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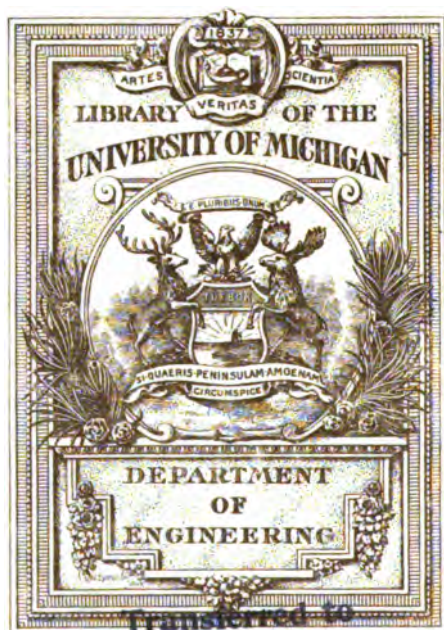
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*American association for
highway improvement*
GOOD ROADS YEAR BOOK

1916



FIFTH ANNUAL EDITION

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PREFACE

It seems probable that during 1916 about \$300,000,000 will be spent on highways and highway bridges in the United States. This is the equivalent of nearly one-third of the total expenditures of the federal government for the fiscal year 1913-1914. It is then apparent that the Good Roads movement is not atrophied by lack of funds. The real problem is that of intelligent and effective use of the large funds actually available. It is to this problem that the American Highway Association addresses its activities. The appeal is to the average citizen who is asked to vote for the issue of highway bonds and who pays road taxes, as well as to the expert. It is an appeal for understanding of the facts of the use of moneys devoted to road building and road maintenance in the interest of the largest economical results. It is then a campaign of general education of road building methods upon which the American Highway Association is engaged. It is not an advocate of a particular method but an exponent and critic of all methods found to be in actual use—the bad as well as the good. It believes in publicity and discussion.

As one means of supplying information to show how the money appropriated for road improvement is being spent, the American Highway Association publishes annually a Good Roads Year Book. This volume is the fifth annual edition. Its purpose is to bring together a general outline of the methods in use in the different states of conducting road improvements and of raising funds for such work; an untechnical and practical explanation of different types of road improvements, culverts and bridges; a statement of the methods of maintenance and of preventing dust, a digest of the current specifications of the highway departments of several states where road work is carried on extensively, an explanation of the principles underlying the different classes of bonds issued to pay for highway improvements, and finally to supply lists of manufacturers of machinery and materials for road work and of societies and clubs interested in the betterment of our highways.

A comparison of the records in this volume with those in the first edition reveals encouraging progress during recent years toward better methods of administering our road building and maintenance work. Each year has shown an extension of the important principle of centralized supervision of highway construction and maintenance in the different states. There is an

increasing body of opinion that in order to make the best use of road funds they should be spent under the direction of men who are devoting their lives to the study and practice of road building. Such men must, of course, be paid adequately for their services. It is sometimes objected that, the highway question being largely a county question, there are many counties which need help yet cannot afford to employ skilled road engineers. The answer of this association is, build up your state highway department. With a strong state highway department it is practicable for counties to have the benefit of technical advice until the time comes when their resources warrant employment of county road engineers.

A strong argument for the creation of a good highway department in every state is to be found in the present status of proposed legislation to extend federal aid toward road improvements. Without undertaking to discuss the policy of that programme, it will suffice to say that it rests for its political justification upon the representation that the rural free delivery of mail matter and the development of the parcel post service have improved the condition of farmers. It is urged that the welfare of the nation warrants further national action to reduce the isolation of farm life by the improvement of rural post roads. The House of Representatives has passed what is known as the Shackleford bill for joint coöperation between the states and the nation in post road improvements. The Senate Committee on post offices and post roads has reported unanimously a modification of this bill, and it is the general opinion that it will be passed at this session or the next. The measure provides for extending substantial federal aid to those states which have efficient highway departments and will expend on their post roads an amount proportionate to the federal contribution. The construction is to be done by the states, subject to the approval of the United States Secretary of Agriculture, and future federal aid will be withheld from the states which fail to maintain properly the roads constructed with such assistance. This measure, if enacted, will undoubtedly result in the creation of state highway departments where none exist today and will strengthen those departments now in a weak condition.

The American Highway Association has been an influential factor in creating the public sentiment that road improvements should be established on a business basis. It is sending out each week to newspapers that have agreed to use the articles, a discussion in popular terms of some phase of good roads. The circulation of the papers receiving these articles is over 5,000,000 copies. The association furnishes speakers for important meetings where road improvements are discussed. It is coöperating with educational institutions and state departments in spreading a knowledge

of what good roads can accomplish for the districts they traverse. This work will be extended as fast as funds are obtained for it. All who believe in getting a dollar's worth of good roads for every dollar invested in construction or maintenance of highways are invited to join the association and thus bear witness in an active and positive way to their coöperation in a work of great economical and social value.

FAIRFAX HARRISON,
President.

April 11, 1916.

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PART I

Information Regarding Road Improvements under Federal, State, Territorial and Local Control

BOOK MARK

HOW TO OPEN A BOOK

LAY the book, back downward, on a table or smooth surface. Press the front cover down until it touches the table, then the back cover, holding the leaves in one hand while you open a few of the leaves at the back, then at the front, alternately pressing them down gently until you reach the center of the volume. This should be done two or three times. Never open a book violently nor bend back the covers. It is liable not only to break the back but to loosen the leaves.

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UNITED STATES OFFICE OF PUBLIC ROADS AND RURAL ENGINEERING

Organization

The Office of Road Inquiry was established by Congress in 1893 to investigate systems of road management and methods of road making, and to make public information on these subjects. During the twenty years following the establishment of the Road Office, these duties were gradually extended and broadened so as to include the physical and chemical testing of road materials, and the conducting of field experiments. In 1912, under the Post Office appropriation bill, Congress placed the construction and improvement of certain post roads under the supervision of this Office. The agricultural appropriation act of 1915 directed the Secretary of Agriculture to submit a plan for reorganizing the work of his Department. The plan he submitted became effective July 1, 1915. The Office of Public Roads became the Office of Public Roads and Rural Engineering, and took charge of all that part of the Department's agricultural work which partook in any way of an engineering nature.

Educational Work.—The work of the Office as now organized may be conveniently grouped into two general classes: (1) Educational or extension; and (2) investigational or research.

The education work is conducted in four stages:

1. Reaching the people by means of lectures, addresses, the publication of bulletins, the exhibit of models, etc., and teaching them the economic value of improved roads and the efficiency of various types.

2. Giving special advice and assistance, where the problem to be solved necessarily involves a knowledge of community and cooperative administration and of methods for planning and financing a system of better roads. At this stage, since the questions are specific rather than general, the lecturer gives way to the engineer.

3. The third step includes an actual demonstration of construction under government supervision. In fact the Office becomes practically a school in regard to road construction.

4. In the fourth step the educational work of the Office deals with the future in so far as it means maintenance. In other words, in order that the communities may realize the fullest re-

turns from their investment, the people are shown how to adequately care for their public roads.

Research Work.—Fully as important as its educational work, however, is the research and experimental work of the Office. Reasonable coordination between the investigations conducted in the laboratories and in the field is constantly sought, and the laboratories have been specially equipped to further this object.

In working out such of these problems as concern the construction and maintenance of roads, Congress has made a special appropriation for field experiments, and during the past three years test roads have been constructed in the vicinity of Washington. These roads demonstrate the use, according to various methods, of a large number of materials, including oils, asphalts, tars, concrete, brick, crushed stone, and gravel. The results of these field experiments are carefully recorded and a progress report issued annually. Every material which is used in the field experiments is carefully tested, analyzed, and studied in the laboratories so that the fullest correlation is obtained.

Organization of the Office.—In order to render its work most effective, the Office is organized into nine divisions, one of which deals entirely with the administrative work of the Office. The other eight divisions are as follows:

Division of Road Construction.—Among projects within the province of this division may be mentioned the following:

1. Object lesson roads, which are built for the purpose of teaching local road officials the proper methods of road construction. All materials, labor, and teams are supplied locally, while the Office of Public Roads and Rural Engineering furnishes the services of an engineer.

2. The county model system project, which involves the assignment of an engineer to a county to make all necessary preliminary investigations for the purpose of devising a plan for the administration, construction, and maintenance of a county system of highways.

3. Bridge and culvert work, which consists of the preparation of typical or standard designs, which will be furnished where suitable, upon application from any particular locality. Special designs are prepared for localities where typical designs can not be used. Occasionally designs prepared by bridge companies are checked and reviewed for local officials. In addition, inspections of bridges are made in conjunction with local officials and advice given as to the kind of bridges and culverts best suited for local use.

4. The superintendence of county roads. This involves the assignment of an engineer to superintend the road work of the county requesting this aid. The engineer assigned makes a thor-

ough study of the county road conditions, with recommendations for improved methods of administration, construction, and maintenance by the properly authorized road officials.

5. The road survey project contemplates extending aid to local communities by providing engineering assistance for making surveys.

6. The post roads project. The Post Office appropriation act of August 24, 1912, appropriated \$500,000 for improving, under the direction of the Secretary of Agriculture, such roads as might be jointly selected by the Postmaster-General and the Secretary of Agriculture. After the roads were selected the Secretary of Agriculture placed them under the immediate supervision of the Office of Public Roads and Rural Engineering. The work under this project comprises sections of seventeen post roads located in thirteen States. Sixteen of these roads were practically completed during 1915.

7. Field experiments in road construction are conducted with a view to ascertaining the relative merits of various road materials in actual service so that the public may benefit by the knowledge thus obtained.

8. Under the project of inspection and advice an engineer is assigned to a locality for the purpose of making a thorough study of all the road-building conditions, which involve materials, methods of construction and maintenance, traffic requirements, and systems of finance and management. He then advises with local officials as to the kind or character of improvements which should be adopted. Special advice is also given concerning isolated problems that frequently exist in connection with the road work of particular localities.

Division of Road Maintenance.—Conservation of the enormous expenditure of public funds in road construction has become so important and the failure of local officials to provide properly for the necessary road maintenance is so general that there has been a great demand on the Office for assistance in this direction. Consequently a Division of Road Maintenance was created on February 16, 1914.

This division aims to become a clearing house for information regarding the details of maintenance work, its cost, methods, and results. To this end studies are being made in States having well organized highway commissions and in selected counties where funds are sufficient to finance an advanced and efficient highway system.

To give a practical demonstration of maintenance in counties having improved roads of the commoner types, such as earth, sand-clay, and gravel, organized maintenance is being conducted along about 725 miles of a through route from Washington, D. C.,

to Atlanta, Ga. Engineers furnished by the Office for this work make frequent inspections of the different sections now under maintenance by the patrol or gang system, and give directions for conducting the work. The various counties cooperating in this work provide the necessary funds, except for engineers' salaries and expenses.

Certain of the post roads improved under supervision of this Office are being used, when completed, to secure maintenance cost data representative of the locality. The work is being conducted in cooperation with the States.

If the greatest benefit is to be derived from the experimental road work conducted by the Office, it is essential to insure the continuous maintenance of these roads, and to obtain very accurate cost data and traffic records. This work is therefore being conducted by the Maintenance Division as a major project. So far, very valuable and original results have been secured and it is expected that the final conclusions will establish the comparative economy of several important types of road with reference to the traffic handled.

Division of National Park and Forest Roads.—This division was created on February 16, 1914. It has charge of certain road work to be done in the National parks, in cooperation with the Department of the Interior, and of road work to be done in some of the national forests, in cooperation with the Forest Service of the Department of Agriculture. Congress has provided that 10 per cent of the receipts of the Forest Service shall be expended in constructing roads and trails within the National forests.

Division of Road Economics.—The work of this division comprises general statistical and research investigations, embodying the collection of data to show national progress in road construction and maintenance, including pertinent laws, appropriations, costs, mileage, dimensions, and types. Under this project at the present time work is under way to secure a census of road mileage, revenues, and expenditures throughout the United States, in accordance with the previous practice of making such a census at five-year intervals.

Investigations begun in 1910 to determine as accurately as possible the economic results of road improvement on the prosperity and development of the country, have been completed and the results are now being prepared for publication. Studies are under way to obtain comprehensive insight into the methods of management, construction, and maintenance of roads under local control, and also into the organization, methods of operation, and results accomplished by the various State highway departments. An exhaustive study of the employment of convict labor in road

work has just been completed. The conclusions drawn from this study are now being given a practical test in an experimental camp in Fulton County, Georgia. In addition to the foregoing economic investigations, similar studies are made along the post roads constructed in coöperation with the Post Office Department, in order to obtain the information called for in the appropriation act which caused their construction. A traffic census is taken at regular intervals on the post roads and on the experimental roads.

This division also has general charge of the lecture work of the Office. Lecturers are only assigned upon request and then only when assured that the meeting has been properly advertised and that the attendance will justify the expense. Closely related to this lecture work is that of road model exhibits which are displayed at various expositions, road conventions, and similar meetings. All editorial and photographic work, together with the library, which comprises approximately 9000 volumes, is also under this division.

Division of Road Material Tests and Research.—The work of this division embraces the following projects:

1. Chemical and physical examination of all types of road materials.
2. Microscopic examination and classification of all rocks, gravels, sands, clays, etc., which are of interest in road construction and maintenance.
3. Standardization of methods of testing bituminous and non-bituminous road materials.
4. Researches into the occurrence, manufacture, and properties of dust preventives and road binders.
5. Investigations of non-bituminous road materials.
6. Inspection and advice.

Under these projects numerous experiments are conducted in coöperation with other divisions of the Office, with a view to correlating laboratory tests with service results.

Samples of rock, gravel, sand, and clay are tested free of charge for any citizen of the United States, provided they are submitted strictly in accordance with printed instructions which are furnished upon request and provided the tests will not only prove of value in perfecting the records of the Office with regard to local deposits but will aid in the dissemination of information of particular value to highway engineers.

In certain instances samples of bituminous materials are tested free of charge, when by so doing information may be secured to further the Office in its efforts to coördinate laboratory tests with service results and when such information will aid it in the prep-

aration of specifications for materials of this character. Tests are not made for municipalities.

The remaining divisions of the Office are not concerned with road work.

Progress Report

During the year ending June 30, 1915, the following object lesson roads were completed: Arkansas, gravel, 1. Florida, oil-sand, 1; bituminous macadam, 2. Georgia, sand-clay, 1. Indiana, sand-clay, 1. North Carolina, earth, 1; top-soil, 1. Oklahoma, earth, 3. Tennessee, earth, 1. Texas, gravel, 1; earth, 1. South Carolina, gravel, 1. An experimental oil-coralline rock road was completed at Buena Vista, Fla., and contracts were let for two roads in Alexandria County, Va., with a total length of 5½ miles which will include 26 experimental sections. Five post roads with a total length of 153 miles were constructed and work progressed on 11 more. The engineers of the Office supervised the construction of 2,266,000 square yards or 257.5 miles of road during the year.

Bridge designs were prepared for 15 locations and at the request of local officials, various State and private plans and specifications were reviewed and 19 inspections made. Three county road systems were prepared, and the engineer in charge of a post road in a Virginia county has coöperated with the State highway department in supervising the construction of 34 miles of gravel road in that county. Engineers were assigned to assist local officials in solving 39 specific road problems, three engineers have assisted the State highway department in its State-aid work, and an engineer has assisted the State geologist of Georgia in examining road materials.

Detailed studies of State road maintenance systems have been made in New Hampshire, Massachusetts, Connecticut and New York, and also of county maintenance systems. The Maryland post road is being maintained by the Office and those in Maine, Ohio and Texas will be taken over for maintenance when completed. Out of the total length of 1037.8 miles of the Washington-Atlanta highway, 723.7 miles are maintained by the Office; the work is done by three engineers, each using an automobile leased from the American Highway Association, and comparative costs of the expense of road supervision using livery and using automobiles are being gathered.

A traffic census has been taken on each post road for a period of one week at three-month intervals and an additional week during the crop-moving season. These counts will furnish definite information concerning the increase in travel due to road improvement. A traffic census has been taken for 24 hours every thir-

teenth day on the experimental roads built by the Office. These counts show the increased travel following the improvement of a road, the cost per ton-mile for construction, maintenance and depreciation; the reduction in the ton-mile transportation charge by reason of greater loads, longer hauls and greater speed; and the effect of traffic of different classes on the different types of construction.

During the fiscal year, 410 lectures and addresses were delivered in 38 States by 32 representatives of the Office. Exhibits of models and photographs were made at 17 fairs and conventions, and similar exhibitions were made before State legislatures and road schools. The physical and chemical testing laboratories examined 1049 samples of road-building materials. Researches into the road-building value of gravels, into the reliability of the present test of the cementing value of rocks, into the effect of frost on the strength of rock and cement mortar, and into the properties of concrete under different working conditions were carried out in the physical laboratories. Investigations have been made of the possibilities of different types of bituminous sand roads. Traction tests have been made to determine the actual effect of road improvements on draft, and of the effect on draft of width of tire, diameter of wheel and method of hitching. A special dynamometer automobile has been built from the plans of the Office for investigations of the effect of different types and conditions of road surface on the power demand on motor cars.

Personnel

Director, Logan Waller Page; assistant director, P. St. J. Wilson; chief of road construction, Vernon M. Peirce; chief of road economics, J. E. Pennybacker; chief of irrigation investigations, Samuel Fortier; chief of drainage investigations, S. H. McCrory; chemical engineer, Prévost Hubbard; chief of rural engineering, Edmund M. McCormick; engineer of tests, Albert T. Goldbeck; chief of road maintenance, Edwin W. James; chief of national park and forest roads, T. Warren Allen; bridge engineer, Oscar L. Grover; chemist, Charles S. Reeve; assistant in road economics, M. O. Eldridge; associate mechanical engineer, E. B. Smith; irrigation economist, R. P. Teele; senior drainage engineer, R. D. Marsden; petrographer, Edwin C. E. Lord; librarian, Grace Francis; editorial clerk, Alice L. Davies; chief clerk, W. Carl Wyatt.

Publications¹

ANNUAL REPORTS

- Report of the special agent and engineer for road inquiry for 1893. Roy Stone.
- Report of the special agent and engineer for road inquiry for 1894. Roy Stone.
- Report of the special agent and engineer for road inquiry for 1895. Roy Stone.
- Report of the special agent and engineer for road inquiry for 1896. Roy Stone.
- Report of the director of the Office of Road Inquiry for 1897. Roy Stone.
- Report of the director of the Office of Road Inquiry for 1898. Martin Dodge.
- Report of the director of the Office of Public Road Inquiries for 1899. Roy Stone.
- Report of the director of the Office of Public Road Inquiries for 1900. Martin Dodge.
- Report of the Office of Public Road Inquiries for 1901. Martin Dodge.
- Report of the Office of Public Road Inquiries for 1902. Martin Dodge.
- Report of the Office of Public Road Inquiries for 1903. Martin Dodge.
- Report of the Office of Public Road Inquiries for 1904. Martin Dodge.
- Report of the director of the Office of Public Roads for 1905. L. W. Page.
- Report of the director of the Office of Public Roads for 1906. L. W. Page.
- Report of the director of the Office of Public Roads for 1907. L. W. Page.
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- Report of the director of the Office of Public Roads for 1912. L. W. Page.
- Report of the director of the Office of Public Roads for 1913. L. W. Page.
- Report of the director of the Office of Public Roads for 1914. L. W. Page.
- Report of the director of the Office of Public Roads for 1915. L. W. Page.

OFFICE OF PUBLIC ROADS BULLETINS

1. State laws relating to the management of roads, enacted in 1888-1893. Compiled by Roy Stone.
2. Proceedings of the Minnesota Good Roads Convention, held at St. Paul, Minn., January 25 and 26, 1894.
3. Improvement of the road system of Georgia. O. H. Sheffield.
4. Report on road-making materials in Arkansas. J. C. Branner.
5. Information regarding road materials and transportation rates in certain States west of the Mississippi River.
6. Information regarding roads, road materials, and freight rates in certain States north of the Ohio River.
7. Information regarding roads and road-making materials in certain eastern and southern States.

¹ The department supply of a number of these publications is exhausted, but copies may be had by purchase from the Superintendent of Documents, Government Printing Office, Washington, D. C. The price is 5 cents each except in the case of bulletins, which range from 5 to 30 cents. A revised list of publications of the Office of Public Roads and Rural Engineering is issued every three months, and copies can be had upon request to that office.

8. Earth roads: hints on their construction and repair. Roy Stone.
9. State aid to road building in New Jersey. Edward Burrough.
10. Proceedings of the National Road Conference, held at Westminster Church, Asbury Park, N. J., July 5 and 6, 1894.
11. Proceedings of the Virginia Good Roads Convention, held in Richmond, Va., October 18, 1894.
12. Wide Tires. Laws of certain States relating to their use, and other pertinent information. Compiled by Roy Stone.
13. Kentucky highways: history of the old and new systems. M. H. Crump.
14. Good roads: extracts from messages of governors. Compiled by Roy Stone.
15. Proceedings of the Good Roads Convention of Texas, held at Turner's Hall, in Houston, Tex., February 19, 1895.
16. Notes on the employment of convicts in connection with road building. Compiled by Roy Stone.
Notes on the employment of convicts in connection with road building. *Revised edition.*
17. Historical and technical papers on road building in the United States. Compiled under the direction of Roy Stone.
18. State laws relating to the management of roads, enacted in 1894-1895. Compiled by Roy Stone.
State laws relating to the management of roads, enacted in 1894-1895. *Supplement.*
19. Progress of road construction in the United States: Reports by Delegates to National Road Parliament, held at Atlanta, Ga., October 17-19, 1895.
20. Traction tests. S. T. Neely.
21. Proceedings of the International Good Roads Congress, held at Buffalo, N. Y., September 16 to 21, 1901.
22. Proceedings of the Third Annual Good Roads Convention of the Board of Supervisors of the State of New York, held at Albany, N. Y., January 28 and 29, 1902.
23. Road conventions in the southern States, and object-lesson roads constructed under the supervision of the Office of Public Road Inquiries, with the coöperation of the Southern Railway.
24. Proceedings of the North Carolina Good Roads Convention, held at Raleigh, February 12 and 13, 1902. Compiled by J. A. Holmes.
25. Proceedings of the Jefferson Memorial and Interstate Good Roads Convention, held at Charlottesville, Va., April 2, 3, and 4, 1902.
26. Proceedings of the National Good Roads Convention, held at St. Louis, Mo., April 27 to 29, 1903.
27. The construction of sand-clay and burnt-clay roads. W. L. Spoon.
28. The decomposition of the feldspars. A. S. Cushman and Prevost Hubbard.
29. The Construction of Macadam Roads. A. B. Fletcher.
30. The Corrosion of Iron. A. S. Cushman.
31. Examination and classification of rocks for roadbuilding, including the physical properties of rocks with reference to their mineral composition and structure. E. C. E. Lord.
32. Public-road mileage, revenues, and expenditures in the United States in 1904. M. O. Eldridge.
33. Road materials of southern and eastern Maine. Prepared in coöperation between the United States Geological Survey, the State Survey Commission of Maine, and the Office of Public Roads. Henry Leighton and E. S. Bastin.
34. Dust preventives. Prevost Hubbard.
35. The preservation of iron and steel. A. S. Cushman.

36. Descriptive catalogue of the road model exhibit of the Office of Public Roads, Alaska-Yukon-Pacific Exposition. Prepared by the Office of Public Roads.
37. Examination and classification of rocks for road building, including the physical properties of rocks with reference to their mineral composition and structure. Edwin C. E. Lord.
38. Methods for the examination of bituminous road materials. Prevost Hubbard and Charles S. Reeve.
39. Highway bridges and culverts. Charles H. Hoyt and William H. Burr.
40. The road material resources of Minnesota. George W. Cooley.
41. Mileage and cost of public roads in the United States in 1909. J. E. Pennybacker, Jr., and Maurice O. Eldridge.
42. New Hampshire highways. Report of an inspection of highways in the State of New Hampshire, August, 1911. Charles H. Hoyt.
- 43.¹ Highway bridges and culverts. Charles H. Hoyt and William H. Burr.
44. The physical testing of rock for road building, including the methods used and the results obtained. June, 1912. Albert T. Goldbeck and Frank H. Jackson.
- 45.¹ Data for use in designing culverts and short span bridges. C. H. Moorefield.
46. Oil-mixed portland cement concrete. August, 1912. L. W. Page.
47. Descriptive catalogue of road models.
48. Repair and maintenance of highways. L. I. Hewes.

DEPARTMENT OF AGRICULTURE BULLETINS

23. Vitrified brick as a paving material for country roads.
53. Object-lesson and experimental roads, and bridge construction of the U. S. Office of Public Roads, 1912-13.
105. Progress reports of experiments in dust prevention and road preservation, 1913.
136. Highway bonds.
220. Descriptive catalogue of road models of Office of Public Roads. (Revision of Office of Public Roads Bulletin 47.)
230. Oil-mixed Portland cement concrete. (Revision of Office of Public Roads Bulletin 46.)
246. Vitrified brick pavements for country roads. (Revision in press.)
249. Portland cement concrete pavements for country roads.
257. Progress reports of experiments in dust prevention and road preservation, 1914.
284. Construction and maintenance of roads and bridges from July 1, 1913, to December 31, 1914.
314. Methods for the examination of bituminous road materials.
347. Methods for the determination of the physical properties of road-building rock.
348. Relation of mineral composition and rock structure to the physical properties of road materials.

CIRCULARS²

14. Addresses on road improvement. Roy Stone.
15. An act to provide for the construction of roads by local assessment, county, and State aid, passed by the New York Assembly.
16. Highway Taxation: Comparative results of labor and money systems.

¹ Out of print.

² Circulars 1 to 13 were of temporary character and are no longer in print.

17. Origin and work of the Darlington Road League. Roy Stone.
18. Report of committee on legislation Adopted by the State Good Roads Convention, held in Richmond, Va., October 10 and 11, 1895.
19. Traffic of the country roads.
20. Comments on systems of maintaining country roads.
21. Methods of constructing macadamized roads. Extract from a report prepared by the chief engineering inspector of the Local Government Board. (England.)
22. Appeal for organization of State and local road-improvement societies. C. A. Locke.
23. Money value of good roads to farmers. W. C. Latta.
24. Highway maintenance and repairs. Revision of Circulars 16, 20, and 24.
25. Brick paving for country roads.
26. Going in debt for good roads.
27. Cost of hauling farm products to market or to shipping points in European countries.
28. Addresses on road improvement in Maine, New York, North Carolina, and Illinois. Roy Stone.
29. The forces which operate to destroy roads, with notes on road stones and problems therewith connected. C. L. Whittle.
30. Repairs on macadam roads. E. G. Harrison.
31. Must the farmer pay for good roads? Otto Dorner.
32. State aid to road building in Minnesota. A. B. Choate.
33. Road improvement in governors' messages. Compiled by Roy Stone.
34. The social, commercial, and economic phases of the road subject. W. H. Moore.
35. Road improvement in New York.
36. List of national, State, and local road associations and kindred organizations in the United States.
37. The railroads and the wagon roads. A. L. Craig.
38. A study of rock decomposition under the action of water. A. S. Cushman.
- 39 to 46 inclusive. Public roads of Washington, Arizona, Arkansas, Oregon, Iowa, Virginia, North Carolina, and Alabama: Mileage and expenditures in 1904. M. O. Eldridge.
47. Tar and oil for road improvement: Report of progress of experiments at Jackson, Tenn.
- 48 to 87 inclusive. Public roads of Tennessee, New Hampshire, Maryland, Maine, New Mexico, Pennsylvania, Montana, Wyoming, North Dakota, South Dakota, Kentucky, Florida, South Carolina, Nebraska, Nevada, Kansas, Idaho, Colorado, Indiana, Oklahoma, Utah, California, Illinois, New Jersey, Missouri, Louisiana, New York, Ohio, Georgia, Mississippi, West Virginia, Wisconsin, Minnesota, Delaware, Michigan, Rhode Island, Massachusetts, Texas, Connecticut, and Vermont: Mileage and expenditures in 1904. M. O. Eldridge.
88. Publications of the Office of Public Roads. Revised June, 1909. Compiled by A. E. Draper. (Out of date.)
89. Progress reports of experiments with dust preventives.
90. Progress reports of experiments in dust prevention, road preservation and road construction.
91. Sand-clay and earth roads in the Middle West. W. L. Spoon.
92. Progress reports of experiments in dust prevention and road preservation.
93. Bitumens and their essential constituents for road construction and maintenance. Prevoet Hubbard.
94. Progress reports of experiments in dust prevention and road preservation, 1910. Prepared by the Office of Public Roads.

- 95. Special road problems in the southern States. D. H. Winslow.
- 96. Naphthalene in road tars. I. The effect of naphthalene upon the consistency of refined tars. Prevost Hubbard and Clifton N. Draper.
- 97. Coke-oven tars of the United States. Prevost Hubbard.
- 98. Progress reports of experiments in dust prevention and road preservation, 1911. December, 1912.
- 99. Progress reports of experiments in dust prevention and road preservation, 1912.
- 100. Typical specifications for the fabrication and erection of steel highway bridges. (Out of print.)

FARMERS' BULLETINS

- 95. Good roads for farmers. M. O. Eldridge.
- 136. Earth roads. M. O. Eldridge.
- 235. Cement mortar and concrete: preparation and use for farm purposes. P. L. Wormeley.
- 239. The corrosion of fence wire. A. S. Cushman.
- 311. Sand-clay and burnt-clay roads. W. L. Spoon.
- 321. The use of the split-log drag on earth roads. D. W. King.
- 338. Macadam roads. A. B. Fletcher.
- 403. The construction of concrete fence posts. Prepared by the Office of Public roads.
- 461. The use of concrete on the farm. Prepared by the Office of Public Roads.
- 505. Benefits of improved roads. September, 1912.
- 597. The road drag and how to use it.

OFFICE OF THE SECRETARY CIRCULARS

- 49. Motor vehicle registrations and revenues, 1914. (Revision in preparation.)
- 52. State highway mileage and expenditures to January 1, 1915. (Revision in preparation.)

SEPARATES FROM THE YEARBOOK OF THE DEPARTMENT OF AGRICULTURE

- 535. Progress and present status of good roads movement in the United States. (1910.)
- 538. State management of public roads: Its development and trend. (1914.)

REPRINTS FROM THE JOURNAL OF AGRICULTURAL RESEARCH

- D-2. Effect of controllable variables upon the penetration test for asphalts and asphalt cements.
- D-3. Relation between properties of hardness and toughness of road-building rock.
- D-4. Apparatus for measuring the wear of concrete roads.
- D-7. A new penetration needle for use in testing bituminous materials.

ALABAMA

State Aid Legislation

The State highway commission consists of a professor of civil engineering in the Alabama Polytechnic Institute, the State geologist, and three civilians appointed by the governor, who hold office for four years. The commission deals with matters of general policy and acts for the highway department in making recommendations to the governor and in all dealings which the highway department may have with the governor and the legislature.

A State highway engineer is chosen by the commission and holds office at their pleasure and he is required to be a competent engineer experienced in road building. He is required to make a general highway plan of the State, collect information, determine the character and supervise the construction of roads built through the aid of the State, and he is further required to prepare a map showing such of the main highways in the State as in his judgment are of sufficient importance to be designated as State roads and which should be improved and maintained at the cost of the State in cooperation with the counties. State funds can be used only on roads designated as State trunk roads.

A cash appropriation is made and apportioned equally to all the counties in the State on condition that the counties provide an equal amount. Any county desiring such aid shall make a written application to the State highway commission and power is given the State highway engineer to approve or disapprove this application. The preparation of plans and specifications and the actual construction of the roads selected are under the direct control of the State highway engineer, who is also authorized to thereafter require that such roads be kept in proper repair, and if the county fails to carry out the recommendations of the State highway engineer in the maintenance of such road, the State highway commission may prescribe rules under which the work may be done by the State and the expense paid by the county, or if the county defaults, the payment shall be made out of any money due the county from the State aid fund.

The appropriation for the last fiscal year was \$154,000 less the expense of operating the State highway department, or an average of \$2000 per county.

Local Road Legislation

Jurisdiction over local roads vests in an elected board of county commissioners consisting of the probate judge and four others,

but, by special statute, boards of revenue or like boards may be created to take the place of boards of county commissioners. A supervisor of roads for an entire county may be appointed by the board. Road taxes may be worked out in counties having less than \$100,000,000 assessed valuation. The board of a county divides it into road precincts and appoints a road overseer for each precinct.

Local Bond Issue Legislation

The court of county commissioners and board of revenue of any county may order an election on the question of issuing bonds of the county for building roads or to pay debts created for the building of roads. After an election is held, another such election shall not be held within one year. A majority vote is necessary to carry. The amount of bonds shall not exceed $3\frac{1}{2}$ per cent of the assessed value of property and shall bear not to exceed 5 per cent interest, shall be sold for not less than par value, and shall run for such time as may be fixed by the court of county commissioners and board of revenue. No specific provision is made by law for retiring such bonds, and this matter presumably is left to the discretion of the court of county commissioners and board of revenue.

Convict Labor Laws

The convicts of any county or municipality may be worked upon the public roads, bridges or ferries of the county under the direction of the court of county commissioners, or they may be hired to other counties. State convicts may be hired by a county.

Highway Officials

State Highway Commission.—Robert E. Spragins, chairman; John Craft, J. B. Rylance, Dr. Eugene A. Smith, State geologist, University of Alabama; G. N. Mitcham, professor of engineering, Alabama Polytechnic Institute; W. S. Keller, State highway engineer, Montgomery; R. P. Boyd, assistant State highway engineer.

Automobile Registration

License fees for private cars: Gasoline, under 25 h.p., \$7.50; 25-30 h.p., \$12.50; 30-40 h.p., \$17.50; 40 h.p. or more, \$20. Electric, \$12.50; Steam, \$15; Motor cycles, \$3; motor cycles with side car, \$5.

License fees for commercial cars: under 40 h.p., same as for private cars; 40 h.p. or more, \$25.

License fees for motor buses: 5 passengers or less, \$25; 5-10 passengers, \$40; 10 or more passengers, \$60, except when running between places 10 miles or more apart, when the fee is \$40.

The licenses are issued by the probate judge of each county, who sends 40 per cent to the treasurer of the city or town where the licensee resides, 40 per cent to the county treasurer and 17½ per cent to the State treasurer, and retains 2½ per cent as commission.

Progress Report

Aid given by State on roads.....	\$175,754
Aid given by State on bridges.....	5,271
Total aid given by the State.....	<u>\$181,025</u>
Amount spent on roads by counties.....	\$2,150,670
Amount spent on bridges by counties.....	514,878
Amount spent on roads by State and counties jointly.....	340,147
Amount spent on bridges by State and counties jointly.....	11,897
Total by State and counties on roads and bridges.....	<u>\$3,017,592</u>

Number of miles of road built April 1, 1914 to April 1, 1915

	<i>Oredos</i>	<i>Topasol</i>	<i>Gravel</i>	<i>Chart</i>	<i>Macadam</i>
By State aid.....	79.83	69.83	27.16	6.94	7.84
By counties.....	504.00	336.50	174.00	185.00	31.70
Totals.....	583.83	406.33	201.16	191.94	39.54
Total number of miles built by State aid and counties.....	1,422.80				
Total number miles improved April 1, 1914.....	<u>5,772.30</u>				
Total number of miles improved road in Alabama April 1, 1915.....	7,195.19				
Number of miles of road in Alabama.....	49,639.00				
Percentage of improved roads in Alabama.....	<u>14.50</u>				

Road Funds

From all counties for construction and maintenance of roads and bridges, \$2,700,000; from State in State aid work for 1916, \$144,000; unexpended balance of 1915 funds, \$27,534; total, \$2,871,534.

Proceeds from bonds in 1915; Franklin County, \$125,000; Conecuh County, \$50,000; total \$175,000.

Interest-bearing warrants; Monroe County, \$125,000; Wilcox County, \$150,000; Marengo County, \$120,000; Fayette County, \$75,000; Henry County, \$100,000; Houston County, \$100,000; Coosa County, \$25,000; Tallapoosa County, \$50,000; Greene County, \$50,000; total, \$790,000.

Total road funds, \$3,836,534.

*Publications***State Highway Department**

- Bulletin 1. State highway laws of Alabama in effect April 5, 1911.
- Bulletin 2. Roads and road materials of Alabama. W. F. Prouty.
- Bulletin 3. First annual report of the State highway commission, 1912.
- Bulletin 4. Second annual report of the State highway commission, 1913.
- Bulletin 5. Addresses by Governor Emmet O'Neal and G. N. Mitcham.
Cost keeping in county road work. R. P. Boyd.
- Bulletin 6. Third annual report of the State highway commission of Alabama.
- Bulletin 7. A suggested road law for counties of Alabama.
- Bulletin 8. Fourth annual report of the State highway commission.
- Bulletin 9. Working Convicts on the Public Roads of Alabama, by W. S. Keller.
- Bulletin 10. Road Laws of Alabama.

Association of Highway Engineers, Annual Proceedings, 1912-13, 1913-14, 1914-15.

[Approved by R. P. Boyd, Assistant State Highway Engineer.]

ALASKA*Laws Governing Road Work*

Road improvements are conducted under an act of Congress of 1905, amended in 1906. It directs all returns from liquor, occupation or trade licenses obtained outside incorporated towns to be placed to the credit of an "Alaska fund," of which at least 65 per cent shall be spent in Alaska for roads, trails and bridges. A board of road commissioners composed of army officers has charge of the location, construction and maintenance of roads and trails, under the restriction that "no such road or trail shall be constructed to any town, camp or settlement which is wholly transitory or of no substantial value or importance for mining, trade, agricultural or manufacturing purposes." Where the total cost of work on any section of road exceeds \$20,000, it must be done by contract, if a bid not unreasonably high is obtained from a responsible party; the work is done by day labor otherwise.

The territory is divided into five districts, with a civil engineer as superintendent in charge of each. The engineer member of the commission is responsible for the execution of the work in conformity with projects developed by the commission as a whole, and similar freedom is given to the disbursing officer.

Progress Report

Alaska had a population of 30,000 to 35,000 in 1905 and has about the same now, engaged almost exclusively in mining and fishing. The area is nearly 600,000 square miles. When the

commission was organized in 1905, there was a primitive mountain road running a short distance from Juneau and a start in road building had been made in the Fairbanks mining district by private subscriptions. Summer travel was only possible on foot or horse-back; most heavy hauling was done in the winter over the snow.

The location of roads and trails gave more trouble than their construction, on account of the unusual local conditions to be satisfied. The roads are earth, except where corduroy or planks surfacing is needed. What is known as the winter sled road type differs from the wagon road in not being crowned, ditched or drained, nor extensively corduroyed, and from the trail in being wider and with better grades and surface. The great obstacles to construction are the permanently frozen ground and the high prices for labor and teams. If some classes of frozen ground are stripped, the exposed surface material will slide in a side hill cutting while on a marsh it may become a quagmire. The problems thus presented must be solved in a variety of ways, in which corduroy construction occupies a prominent place. Ditching in some classes of frozen soil is also very difficult, but is necessary as the ground is very wet on the surface. On the coast line the excessive rainfall and the character of the country traversed make the work more expensive than in the interior.

Roads are cleared for an average width of 24 feet, while the average roadway is 12 feet wide. On side hill roads with light traffic and where corduroy construction is very expensive the width is reduced somewhat, 8 feet being the minimum. As a result of the work done up to 1913, the commission estimated that the saving in cost of transportation effected in that year by the existence of the roads was over \$2,100,000.

Up to the close of the working season of 1915, the commission had constructed and maintained 901.8 miles of wagon roads, 577.5 miles of winter sled roads and 2,216.5 miles of trails, at a total expense of \$3,089,414. Of this sum \$1,489,414 came from the Alaska fund and the remainder from congressional appropriations. Owing to the burning of the commission's records on July 15, 1915, it is impossible to say how much has been received from a local road tax since repealed and from municipal and private donations. The average cost of wagon roads is \$3000 per mile, winter sled roads \$325, and trails \$100. Although none of the roads is classed as an automobile road, about 100 trucks and cars use them. Maintenance charges are heavy on some sections, particularly where summer floods are of large volume.

Funds

Money for road work under the commission is derived from the Alaska fund, congressional appropriations and private donations. A poll tax of \$4 is levied for roads by the territorial legislature.

In the fiscal year 1914-15, the Alaska fund yielded \$171,824 and the congressional appropriation was \$125,000. The expenditures were \$284,755. It is expected that the funds for the current year will be about the same.

Highway Officials

Board of Road Commissioners.—Colonel W. P. Richardson, president; Major P. W. Davison, secretary and disbursing officer; First Lieutenant J. C. Mehaffey, engineer officer. Offices, Valdez.

Publications

Annual reports, 1906-1915.

[Approved by Col. W. P. RICHARDSON,
President, Alaska Road Commission.]

ARIZONA

State Aid Legislation

The State engineer is appointed by the governor by and with the advice and consent of the senate, and is required to be a competent civil engineer. He prepares plans and specifications for State highways and bridges and all State highway work is done under his supervision.

For construction purposes an annual running appropriation of \$250,000 is made. Seventy-five per cent of this appropriation is to be expended in the counties in which raised under the direction of the county boards of supervisors and the State engineer; 25 per cent to be expended under the direction of the State board of control (the governor, auditor and citizen member, appointed by the governor), and the State engineer. All engineering expenses to be paid out of the 25 per cent portion.

Local Road Legislation

Jurisdiction over public roads vests in a county board of supervisors, who may appoint a county road engineer with a salary not exceeding \$3000 a year. State wide tire legislation is operative only in counties where the supervisors have adopted it. Special road assessment districts, not over 10 miles long and 1 mile wide, may be formed and road bonds issued on it by a vote of the electors.

Convict Labor Laws

State convicts may be used on road construction under laws which provide for meeting the cost of such labor from two sources, namely, the prison maintenance fund, contributing an amount equal to the expense of keeping the given number of convicts in the State prison, and the State road tax fund, contributing the remainder needed for guarding, transportation, housing, food, tools and supplies. Counties employing this convict labor are not entitled to other aid from the State road tax fund except strictly engineering services.

During the fiscal year beginning July 1, 1914, 9072½ days of prison labor under the honor system were used on highways at an average cost of \$1.15, and 3583½ days of prison labor under guard at an average cost of \$1.516. Paid labor was substituted for prisoners under guard early in the year on account of the large number of citizens thrown out of work by the closing down of Arizona mines. This reduced the amount of prison labor under guard to about one-tenth of that originally contemplated.

Local Bond Issue Legislation

The board of trustees of any road district may, when it is deemed necessary or advisable to expend a larger amount than can be raised by the tax of 75 cents, call an election and submit the question of bonds to the voters of the district. A two-thirds favorable vote authorizes the issuance and sale of bonds, which shall run for not more than twenty years, shall bear interest not exceeding 6 per cent, payable annually, and shall not be sold for less than par. The board of supervisors shall levy a tax sufficient to pay interest and retire bonds at the end of their term, although the board may provide for bonds to be retired serially.

Automobile Registration

The law provides for annual registration with the secretary of State. The registration fees are as follows: 25 h.p. and less, \$5; 25 to 40 h.p., \$10; over 40 h.p., \$15; motor cycles, \$2; dealers, one machine in each class, at regular rates; chauffeur's license, \$5.

The revenues are credited to the State road tax fund.

Highway Officials

Board of Control.—Geo. W. P. Hunt, governor; J. C. Callaghan, State auditor; Chas. R. Osburn, citizen member and secretary; Lamar Cobb, State engineer, Phoenix. The staff is under T. F. Nichols, office engineer, and E. P. Adams, chief clerk.

Progress Report

During the fiscal year July 1, 1914, to July 30, 1915, there was expended under the direction of the State highway department for bridges, \$87,011.54; highways, \$290,947.12; engineering, \$31,446.31; administration and executive work, \$18,051.50; equipment, \$23,738.06; maintenance, \$24,983.80; total, \$476,178.33.

There were constructed as projects distinct from highway work a Luten arch 140 feet long, a 642-foot deck girder concrete bridge, and three concrete trestles 117, 84 and 75 feet long respectively.

There were 28.875 miles of road graded and 1817 feet of corrugated iron culverts installed, a 100-foot and a 30-foot concrete trestle built, 10 concrete boxes and 525 linear feet of concrete paving laid over small washes. There were 26.069 miles of road surfaced (10.06 miles of which being old road reconstructed and surfacing applied) including the installation of 5115 feet of corrugated iron culverts and the construction of a 40-foot rail-top culvert, a 100-foot concrete trestle, a 28-foot concrete arch and a rail-top culvert 23 feet in length. In addition 24.2 miles of old road were recrowned and drainage cared for with prison labor, and some miscellaneous work done on roads graded or surfaced in previous years. The department maintained 164.9 miles of road previously constructed.

Available Funds

For the fiscal year 1915-16 there is available for State highway construction the following:

From annual appropriation under the State Highway Law of June 20, 1912.....	\$250,000
Special appropriation of the Legislature of 1915 for working prisoners.....	70,000
Special appropriation of the Legislature of 1915 for bridges....	45,000
Special appropriation of the Legislature of 1915 for repair of Borderland Trans-continental Highway.....	10,000
Fees received from motor vehicle licenses.....	50,000

Total State funds.....	\$425,000
To be expended by counties (exclusive of bond issues estimated)	575,000
To be expended by counties under bond issues.....	*500,000

Total State and county..... \$1,500,000

* There has been voted \$750,000 in bonds by counties and it is estimated \$500,000 of this amount will be expended during the present fiscal year.

[Approved by E. P. ADAMS, Chief Clerk.]

ARKANSAS

State Aid Legislation

An act approved March 31, 1913, provided for forming the State land office into a department of State lands, highways, and improvements, and created in connection with it a State highway commission and a highway improvement fund. The State highway commission is to consist of three members, as follows: Commissioner of State lands, highways, and improvements, chairman; two members to be appointed by the governor to serve, respectively, one and two years; thereafter, as the terms expire, each commissioner appointed shall serve two years. The existence of the State highway commission is limited to thirty years.

The commissioner of State lands, highways, and improvements is required to appoint a State highway engineer subject to the approval of the commission, who shall be a graduate in engineering of some reputable school of engineering and skilled in road building. He holds office for the term of two years.

A highway improvement fund is created, composed of funds derived from motor-vehicle fees and licenses being one-half the total \$10 fee or \$5 per vehicle.

The department is required to collect data, see that road laws are enforced, hold road institutes at least once a year, which county judges, county engineers, and road overseers are required to attend, and for which they are to receive the same pay as if they were engaged in actual road work. The department is required to furnish plans and specifications when requested to do so, and aid in the formation and management of highway improvement districts. The department is authorized to determine the method of distribution of any State road funds that may be available.

The highway improvement districts are created on application to the county courts, giving description of the roads to be improved and the territory traversed by them.

The department is authorized to employ State convicts on the public roads or for public road purposes.

Local Road Legislation

Jurisdiction over roads vests in the county court, of which the probate judge is chairman. Road officials are appointed by him. Road taxes may be worked out. Special assessment districts for road construction may be formed upon petition of a majority of the property owners. The cost is assessed upon the property

and the work done under the supervision of three commissioners receiving \$5 per day each when actually employed.

Local Bond Issue Legislation

The board of commissioners of a road improvement district may issue bonds to run not over thirty years, retired either serially or by a sinking fund.

Convict Labor Laws

The department of State lands, highways and improvements shall employ as many of the State convicts on the public roads as may not be otherwise employed by the penitentiary authorities, the expenses to be borne by the county or improvement district in which they work.

County convicts may be worked upon the highways of the county, and it is lawful to provide in any highway charter for working the male county convicts upon the highways of the county. In case such district is not coextensive with the county from which they come, the county court shall first approve the provision. Special improvement districts may use convict labor and pay a flat rate of 75 cents to the county.

Automobile Registration

The law requires annual registration with the commissioner of State lands, highways and improvements, payment to be made to the county tax collector, whose receipt is forwarded with the application for registration. The fees are as follows: All motor vehicles, \$10; dealers, one machine in each class, at regular rate; chauffeur's license, \$1.

The revenues are equally divided between the State and the county in which the revenue is collected, the State portion to be credited to the State highway improvement fund. The fees and forfeitures are paid into the general school fund of the county in which they are imposed. (Act No. 134, Laws 1911, as amended by Act No. 302, Laws 1913.)

Highway Officials

State Highway Commission. Five members, of which the commissioner of State lands, highways and improvements, is chairman, appoints a State highway engineer. The present State highway engineer is H. R. Carter, at Little Rock.

Progress Report

According to a chart prepared by the State highway department, there are more than 30,000 miles of public road in the State, as follows: 12,000 miles of unimproved earth; 13,000 miles of improved earth; 250 miles of sand clay; 220 miles of gravel; 265 miles of macadam; 655 miles of other types.

It is anticipated that approximately 256 miles of gravel and 153 miles of macadam road will be constructed during the coming year.

Approximately \$1,163,000 derived from the 3 mill tax was expended during 1914.

State Road Funds

Approximate funds available for 1916: automobile licenses and fees from sale of State lands, \$60,000; from 3 mill tax (to be spent by counties) \$1,300,000; total \$1,360,000.

Publications

Highway Bulletin. Issued monthly by State Highway Commission.

[Approved by H. R. CARTER, State Highway Engineer.]

CALIFORNIA*State Aid Legislation*

The State provided by a referendum vote of the people, effective December 31, 1910, for a bond issue of \$18,000,000 under the "State Highways Act," which defines in a general way the roads to be built. This work is under the general direction of the advisory board of the State department of engineering, consisting of the governor, who is ex-officio chairman; the State engineer; the general superintendent of State hospitals; the chairman of the State board of harbor commissioners of San Francisco; and three members appointed by the governor. It is directly administered by the three appointed members, who are designated by a resolution of the advisory board of the department of engineering as the California Highway Commission, and given by resolution full authority over construction of the system of State highways under the \$18,000,000 State bond issue. The highway engineer, appointed by the governor, is the executive officer of the commission, and in his charge is placed the construction of the State highways system.

The State highways, in the language of the act providing the bond issue, are being acquired and constructed through the

Sacramento and San Joaquin valleys, and along the Pacific Coast, connecting county seats lying east and west of the main routes. This system is to be constructed and maintained at the expense of the State, except that each county must pay into the treasury 4 per cent per annum upon the sum of money expended in such county in the construction of State highways, less such portion of the amount expended as the bonds matured shall bear to the total number of bonds outstanding. The State highways extend from the Oregon boundary to San Diego and El Centre, the most southerly county seats, and are maintained through funds derived from the State license fee imposed upon motor vehicles.

The State department of engineering has general authority over all participations by the State in works of highway improvement, and is given authority to make investigations regarding highway betterment or extension which may be deemed desirable. In addition to the system of State highways, provided by bond issue, such appropriations are made from time to time for construction of roads of State importance, particularly in mountainous sections and in localities where the sparse population makes the expense an undue legal tax burden.

Local Road Legislation

County supervisors, of whom there are five in each county, elected for a term of four years in November of even years, have authority over roads. The county surveyor is elected.

Local Bond Issue Legislation

Upon petition of a number of freeholder electors of any county equal to 10 per cent of the last vote cast for governor, praying that the issuance of bonds for highway purposes be submitted to the electors, the county supervisors may appoint a highway commission of three members for such county to investigate the main roads and report to the board of supervisors those roads that should be improved, their estimated cost and the amount of bonds to be issued. If this report is approved by the board of supervisors, an election on the issuance of the bonds shall immediately be called. A two-thirds majority vote of the qualified electors is required. The term and rate of interest is not specified in the act. All work done with the proceeds of the bond issue shall be under the direction of the highway commission.

The county supervisors of any county may create road districts under two different acts. A *permanent road district* (act of March 19, 1907) may be created upon the petition of a majority of the

land owners of the proposed district, who may, in their petition, propose a bond issue for certain road improvements, and this bond issue shall be submitted by the supervisors to the electors of the district, and if two-thirds of the votes cast are favorable, then bonds of the district shall be issued not to exceed 15 per cent of the assessed valuation, to run not to exceed twenty years, and to bear interest at not to exceed 7 per cent per annum. The bonds shall be sold to the highest bidder at not less than par, and the work authorized shall be done by contract to be let to the lowest responsible bidder. A *special road district* (act of March 21, 1907), for certain specified improvements on established roads may be created by the county supervisors after giving notice of the proposal, if a majority of the land owners of the proposed district do not file objections thereto prior to the date set for hearing objections. Upon the creation of the district, contracts under the approved specifications shall be awarded to the lowest responsible bidder and, upon the completion and acceptance of the work, bonds of the district shall be issued to pay for this work, to run not to exceed twenty years, and bear interest at not to exceed 7 per cent per annum. Under both acts a tax shall be levied to pay interest and principal when due, although in the case of bonds issued by a special road district the county supervisors may make transfers of funds for the payment of interest and principal when due.

Convict Labor Law

An act authorizing the use of convict labor on State highways was passed in 1915. Upon the requisition of the Department of Engineering, the State Board of Prison Directors shall send to the place, and at the time designated, the number of convicts requisitioned, or such portion thereof as are available, in the judgment of the warden. The department of engineering designates and supervises the road work done and provides and maintains necessary camps and commissariats. The State board of prison directors has full jurisdiction at all times over the discipline and control of convicts employed on the State roads. The convicts so employed are compensated by being allowed a reduction of their time to serve in prison, not to exceed one day for each two calendar days that the convict is absent from the prison.

Automobile Registration

A new motor vehicle act became effective on January 1, 1916. Annual registration is required, the application to be forwarded to the motor vehicle department with fee, which issues the necessary number plates, etc., and makes record. Registration fees are as follows:

For the registration of every automobile, except electric motor vehicles, 40 cents for each horse power or major fraction thereof. A graduated fee for every motor vehicle equipped with other than pneumatic tires and used for commercial purposes, according to weights, in addition to regular fees. Electric motor vehicles, \$5; motorcycles, \$2. Dealers, for each 5 cars operated, \$25, and \$2 for every automobile in excess of 5 so operated, including the necessary number plates. Motorcycle dealers, \$5. Chauffeur's license, \$2.

Highway Officials

State Highway Commission, Sacramento.—Charles D. Blaney, Saratoga, chairman, Newell D. Darlington, Los Angeles, Chas. F. Stern, Eureka.

Austin B. Fletcher, formerly the secretary and chief executive officer of the Massachusetts highway commission, is the highway engineer and executive officer of the commission. Wilson R. Ellis of Berkeley is secretary of the commission.

The headquarters office is at Sacramento and the division offices are maintained in San Francisco, Los Angeles, Dunsmuir, Fresno, San Luis Obispo and Willits.

Progress Report

The State highway work has been in progress since the spring of 1912, the funds being provided by a bond issue of \$18,000,000. There has been no rigid standard of pavement adopted by those in charge of the work, but the type and width have been selected to fit the traffic needs of the locality.

On January 1, 1916, the commission had 972 miles of completed highway and 473 miles under construction. Of this 1445 miles of highway, there are 930 miles of concrete base with thin bituminous wearing surface, 26 miles of concrete base with sheet asphalt surface, 16.5 miles of macadam base with Topeka wearing surface, 19 miles of oil macadam, and about 440 miles of graded road.

In December, 1914, of the \$18,000,000, approximately \$6,900,000 had been expended. During the year 1915 approximately \$8,000,000 was used, and the balance of \$3,000,000 will probably be spent during 1916. The trunk lines have seemed to require rather expensive paving, and as the work has progressed it has become more and more evident that the \$18,000,000 will not be sufficient to complete the system in a satisfactory manner. The legislature at its 1915 session became convinced of this fact and provided for a bond issue election to be held in November, 1916. At that time the people will vote on a new issue, \$15,000,000 in amount, to be used to complete the system outlined in the present

State highways act, and to round out the scheme by the construction of certain connecting roads not contemplated in the present law.

The maintenance of the State and certain county roads is taken care of by a fund collected from the license tax on motor vehicles. During 1915 approximately \$1,500,000 was collected. After deducting the cost of licenses and collection, half the money is used for the maintenance of State highways and the other half divided among the counties of the State in proportion to the amount collected from each county for licenses, this amount to be used in the maintenance of county highways.

Publications

Report Surveyor General, 1854

Comments on California and Missouri mail stage road, and Atlantic and Pacific Railroad; also recommendation for appropriation for locating and constructing portion of proposed California and Missouri stage road lying between some point in great central valley of State, and its eastern boundary.

State Convention of Supervisors, San José, 1896.

Road sprinkling. Paper read before State Convention of County Supervisors at San José, by M. Manson. 1896.

Commissioner of Public Works

Reports, 1894 to 1904.

Department of Highways

Biennial Reports, 1895-96 to 1904-06.

Bulletin 1. An act to create a bureau of highways and prescribe its duties and powers and to make an appropriation for its expenses (1895).

Bulletin 2. An act providing for the erection and operation of rock crushing plants at the State prisons for the preparation of highway material for the benefit of the people of the State, and providing for the necessary advances and appropriation of money to carry out said work (1895).

Bulletin 3. Physical features of the State.

Bulletin 4. The effect of roads on industrial development.

Bulletin 5. Proposed highway legislation with comments and resolutions thereon.

State Engineer

Reports from 1878-79 to 1908-10-12.

State Mineralogist

Reports, twelfth, 1892-04; thirteenth, 1894-96.

(Macadam in Alameda, Los Angeles, Marin, San Francisco, Solano, and Sonoma Counties.)

California's State Highway. Austin B. Fletcher, Highway Engineer, California Highway Commission, August 5, 1912.

California Highway Bulletin, issued from time to time by California Highway Commission, Sacramento.

[Approved by A. B. FLETCHER, State Highway Engineer.]

COLORADO

Good Roads Legislation

The State highway commission consists of a highway commissioner, appointed by the governor, and an advisory board of five members, holding office from one to five years, respectively. The commission is required to meet four times a year and to appoint a secretary, who is required to be a civil engineer and a practical road builder, to hold office at the pleasure of the commission. The commission is required to prepare a map showing the public roads in each county connecting the roads of sufficient importance to receive State aid and form a connecting system of State roads. The commission is given authority to designate the most important roads as the first to be improved. They are also authorized to make investigations to ascertain the location of road material, etc. The commission is given authority to apportion the State road fund among the counties, taking into consideration area, amount of money expended in construction, difficulty and extent of such construction, and extraordinary expenses in connection with the development of new territory. The counties receiving such aid are required to raise an amount equal to the amount set aside by the State, unless the State highway commission should desire to extend further aid to poorer counties, in which case they may extend it to the extent of \$5 of State money to \$1 of the county's. All money apportioned to counties and not accepted by them is distributed to other counties. The county commissioners are to designate the roads to receive State aid, subject to the approval of the State highway commissioner. The county commissioners must make surveys, prepare plans and specifications, and make estimates and submit them to the State highway commissioner for approval. Contracts are let by the county commissioners after approval by the State highway commissioner. Construction and maintenance are under the supervision of the county commissioners, subject to the approval of the State highway commissioner. The money apportioned by the State highway commission shall be paid to the treasurer of the county on estimates from the State highway commissioner as the work progresses. Annual reports must be made by the county commissioners to the State highway commissioner of all moneys expended on roads during the current year.

Appropriations for State highways are made directly by the legislature.

Local Road Legislation

In each county a board of three county commissioners serving 4-year terms has jurisdiction over local roads. They may appoint a general overseer for all such roads or divide the county into districts and appoint a district overseer for each.

An act of the legislature passed in 1913 providing that the county commissioners in counties having a revenue of \$12,000 or more may elect a county road supervisor to have entire supervision of all the roads and bridges in the county. He is required to make a complete report on the first of each month, which report after approval by the county commissioners is forwarded to the State highway commissioner. He is required to attend at least one meeting annually at the capitol called by the State highway commissioner.

Local Bond Legislation

When the county commissioners of any county shall deem it necessary to create a county indebtedness for road and bridge purposes, they may submit the proposition to a vote and, if a majority of the votes cast are in favor of the proposition, they may issue bonds of the county in the aggregate not to exceed the following: Counties of assessed valuation less than \$5,000,000, \$3 on each \$1000; and counties of assessed valuation over \$5,000,000, \$1.50 on each \$1000. These bonds shall bear interest not exceeding 10 per cent per annum and shall be payable at the pleasure of the county after ten years, but absolutely due and payable twenty years from the date of issue. To pay the interest on such bonds, an annual tax shall be levied by the county commissioners, and for their ultimate redemption the county commissioners shall levy annually, after ten years, a tax upon all taxable property in the county in such an amount as to create a yearly fund equal to 10 per cent of the whole amount of the bonds. The proceeds of these bonds shall be used only for the purpose for which they were issued. (Constitution, article xi, Section 6.)

Under Section 1364, revised statutes of 1908, the aggregate amount of road and bridge bonds in counties with an assessed valuation of \$1,000,000 to \$5,000,000 is fixed at \$12 per \$1000, and in counties with over \$5,000,000 assessed valuation at \$6 per \$1000.

Convict Labor Laws

At the request of the board of county commissioners the warden of the State penitentiary shall detail such a number of prisoners to work on the public roads as he shall deem proper. The additional cost of guarding and other expense must be borne by the county.

Automobile Registration

Annual registration with the secretary of State is required. The fees are as follows: 20 h.p. and less, \$2.50; 21 h. p. and 40 h.p., \$5; 41 h.p. and over, \$10; motorcycles, \$2; chauffeur's license, \$1.

Revenues are divided equally between the State and the county from which the revenue is received. The State's portion is credited to the State road fund, to be expended in improving and maintaining State roads, and the counties' portion is credited to the road fund of such county. Fines and forfeitures are divided equally between the State and the county and credited in the same way as the registration fees. (Act No. 49, Laws 1913.)

Highway Officials

State highway commissioner. T. J. Ehrhart, of Denver, Colorado. There is an advisory board of five members, composed at this time of J. M. Kuykendall, chairman, Denver; Leonard E. Curtis, v. chairman, Colorado Springs; Chas. R. McLain, member, Canon City; L. Boyd Walbridge, member, Meeker; C. E. Herr, member, Durango, and secretary and engineer, J. E. Maloney, Littleton; stenographer, A. A. Ross, Denver.

Progress Report

The total length of roads in the State is estimated to be 31,000 miles, of which 550 miles are estimated to be hard surfaced. No roads have been completed entirely at the expense of the State, but it is estimated that 5500 miles have been improved partly at the expense of the State and partly at the expense of local subdivisions. An additional 600 miles are in course of improvement jointly by the State and sub-divisions. No roads are maintained at the expense of the State but there are approximately 6000 miles maintained under the direction of the county commissioners for which the State pays a portion of the cost. There were 500 miles of road graded and drained and about 50 miles of road surfaced with gravel, shale, sand or clay, under the direction of the State highway commission during the calendar year 1915. The total expenditure of State funds on State roads during 1915 was \$202,000, and of county funds on these roads approximately \$400,000, making a total expenditure on State road system for the year of approximately \$602,000.

Five convict camps of approximately 50 men each were worked on the roads in different portions of the State during the year.

The grading and ditching on the 500 miles of State road during 1915 averaged about \$600 per mile. About 90 bridges were built,

of steel and reinforced concrete, at an average cost of \$1000 each; 500 culverts were placed at an average cost of about \$50 each. The 50 miles of road surfaced with gravel, shale, sand or clay averaged about \$800 per mile. The balance of the expenditure is for dragging and maintenance. The expenditure on county roads of the State amounted to about \$600,000, on some 20,000 miles of road. Work has been in progress in every county in the State and the main passes have been improved so as to permit travel with comfort.

Road Funds

The funds available for expenditures by this department will amount to about \$700,000 for this year.

In meeting this amount the counties will put up probably about \$500,000. This amount will be spent on the State primary road system. In addition to this, the counties will raise by their tax levy for roads and bridges about \$950,000 which will be spent on all roads other than State roads, or a total of \$2,150,000, although it is possible that about \$250,000 of this latter amount may be diverted to use upon the State road systems. The sources of the State fund are as follows: One-half mill levy for State road purposes, will yield approximately \$600,000 (part of this fund anticipated); receipts from automobile license, \$50,000; amount received from the internal improvement income and permanent fund, \$90,000. The county fund is raised entirely by direct levy for roads and bridge purposes.

Publications

State Highway Commission

Biennial Report, first and second, 1910-1912, 1913-1914.

Bulletin 1. Act establishing highway commission, 1910, Regulations, etc.

Bulletin 2. Act establishing highway commission, 1911, and road laws of Colorado.

Bulletin 3. General rules, regulations and highway commission Act. 1913.

Bulletin 4. General forms, specifications and plans, 1914.

[Approved by J. E. MALONEY, Secretary and Engineer.]

CONNECTICUT

State Aid Legislation

A State highway commissioner, who shall be a capable road builder, is appointed by the governor with the consent of the senate and holds office for four years. He has a right to enter any town in the State and lay out and improve any trunk line

roads and certify the cost of the same to the State comptroller for payment. He has authority to approve the application of the selectmen of any town for State aid, to select the highway to be improved with such aid, make surveys, plans and specifications therefor, determine the character to the road, and have supervision of the construction. He has the right to reject any and all bids, and where the cost is less than \$1000 he may at his discretion, permit the town to do the work. He shall keep all State roads in repair and certify the cost of the comptroller. He is authorized to appoint a deputy commissioner, eight division engineers, and such other assistants as he may deem necessary and fix their salaries.

Whenever any town desires to improve a public road by the aid of the State the selectmen of the town shall make application to the State highway commissioner for such aid, such application to be subject to his approval. The aid granted by the State is apportioned as follows: In towns having a taxable valuation of over \$1,250,000 the State pays three-fourths of the cost of roads constructed as State aid roads, and in towns having a valuation of \$1,250,000 or less the State pays seven-eighths of the cost of such construction. The law permits the use of two years' appropriation in one year. A trunk line system, comprising the principal roads of the State, is gradually being constructed and maintained entirely at the cost of the State. The State highway commissioner is authorized to lay out, widen and grade any highway in the State whenever he deems it necessary for the purpose of connecting with the trunk line highways. Under the new law, towns are permitted to improve State aid roads with their own funds and recover their proportion of the cost of said improvement under a subsequent appropriation by the State. Said work must be done under the supervision of the State highway department and must not exceed an amount designated by said department.

The maintenance of trunk-line roads is paid for entirely by the State, while the maintenance of State roads other than those on the trunk lines is borne by the State and town in the ratio of three-fourths and one-fourth respectively. All moneys received by the State from automobile licenses and fines are applied for road maintenance. A law of 1915 directs the highway commissioner to erect and maintain uniform direction and danger signs on trunk line highways.

A law of 1915 provides that the highway commissioner may petition the public utilities commission for authority to eliminate dangerous conditions on trunk line highways. This is a distinct departure from the previous policy of the State.

Local Road Legislation

Local road work is under the board of selectmen of each town, selected annually. If they refuse or neglect to maintain the roads, the board of county commissioners may order the work done, when petitioned to do so.

Bridges

The legislature of 1915 passed a law which places under the jurisdiction of the highway department all trunk line highway bridges having a span greater than 25 feet, whether these bridges are located on improved sections of road or not. When bridges are between two towns or two counties, the State pays half of the cost and the two towns or counties the other half. When any lines of an electric street railway company cross such bridge, the expense is divided one-third by the State, one-third by the railway company and one-third by the town or towns.

A law of 1915 directs the highway commissioner to investigate the condition of all bridges having a span greater than 25 feet on trunk line highways and to file a report with the General Assembly of 1917.

Automobile Registration

Annual registration with the secretary of State is required. Registration fees are as follows:

Automobiles, 50 cents per horse power; motor vehicles, \$2; registration of all motor vehicles owned by a dealer in automobiles and motor trucks, \$50; registration of all motor vehicles owned by a dealer in motorcycles, \$10; substitution of the registration of a motor vehicle, except a motorcycle, previously registered, \$1; substitution of the registration of a motorcycle, 50 cents; for each motor vehicle engine owned by a manufacturer of motor vehicles and tested or operated on the highways of this State, \$1; minimum charge to any manufacturer, \$25.

Commercial motor vehicles

CAPACITY		CAPACITY	
<i>pounds</i>		<i>pounds</i>	
1,000	\$11.00	11,000	\$87.50
2,000	15.00	12,000	100.00
3,000	20.00	13,000	112.50
4,000	25.00	14,000	125.00
5,000	30.00	15,000	150.00
6,000	35.00	16,000	175.00
7,000	45.00	18,000	200.00
8,000	55.00	20,000	225.00
9,000	65.00	Each additional ton...	50.00
10,000	75.00		

Highway Officials

State highway commissioner, Charles J. Bennett, Hartford; deputy highway commissioner, Richard L. Saunders, Hartford; superintendent of repairs, W. LeRoy Ulrich, Hartford; chief clerk, Clinton G. Nichols, Hartford; division engineers: Robert S. Hulbert, Winsted, Elmer C. Welden, Willimantic; Carrol A. Campbell, Middletown; George E. Smith, New Milford; Orrin W. Head, New Haven; Robert W. Stevens, Hartford.

All positions in the highway department, except those of commissioner and deputy commissioner, are under civil service.

Progress Report

During the year ending September 30, 1915, \$620,091.91 was spent for State aid construction, \$361,098.52 for trunk line construction; \$200,000 for trunk line reconstruction, \$778,000 for maintenance of trunk lines, and \$165,741.54 for maintenance of State aid roads.

Funds for Road Work

No appropriation for new work was made by the legislature of 1915.

The appropriation made in 1915 for the maintenance of State aid roads was \$150,000 a year for two years, and for the maintenance and reconstruction of trunk line highways it was \$500,000 a year for two years. These appropriations run to September 30, 1917. The receipts from automobile registration, approximately \$650,000 a year, are also placed to the credit of the fund for maintaining and reconstructing trunk line highways.

An appropriation of \$200,000 was made in 1915 for building and maintaining bridges of 25 feet or more span on trunk line highways.

Publications

State Highway Commissioner

Annual Reports, 1895 to 1900, inclusive.

Biennial Reports, 1901-02 to 1907-08, inclusive, 1913-14.

[Approved by C. G. NICHOLS, Chief Clerk.]

DELAWARE

State Aid Legislation

There are three counties in the State one of which, New Castle County, has a State highway commissioner for the county, appointed by the governor.

Local Road Legislation

Jurisdiction over the local roads vests in the county courts, called levy courts, except as mentioned above, which appoint the county road engineers. State wide-tire legislation is only operative where the county courts have adopted it. A rebate from property road taxes is granted to those complying with the wide-tire law.

Convict Labor Laws

In the counties of Kent and Sussex, vagrants and minor criminals may be sentenced to hard work on the county roads.

In New Castle County, the levy court is empowered to arrange for employing any of the able bodied convicts on the public roads.

Automobile Registration

The law provides for annual registration with the secretary of State. The schedule of fees is as follows: Motor cycles, \$3; all other motor vehicles, \$5; operators, including owners, \$5; manufacturers and dealers, for each car demonstrated on the roads, \$5.

Registration revenues are credited to the general fund of the State treasury.

Highway Officials

New Castle County Levy Court.—E. B. Hollingsworth, Montchanin, president; S. J. Burris, Wilmington; W. T. Purks, Wilmington; B. A. Groves, Marshallton; M. E. Smith, Rosehill; T. S. Fouracre, Middletown; W. A. Scott, Townsend.

New Castle County State highway commissioner, James Wilson, who is a State official, and has charge of the building of improved roads and is also county engineer.

Kent County Levy Court.—W. Hart Scott, county engineer, Dover.

Sussex County.—M. T. Gum, county engineer, Georgetown.

[Approved by JAMES WILSON, State Highway Commissioner.]

DISTRICT OF COLUMBIA

Control of Roads

The commissioners forward to congress, through the secretary of the treasury, estimates of proposed expenditures for each fiscal year ending June 30. To the extent to which these estimates are approved, inasmuch as the National government owns fully one-half in value of the property in the District, congress appropriates 50 per cent, and a like proportion is paid from the District revenues.

Automobile Registration

Regulations provide for registration with automobile board. Schedule of fees is as follows: All motor vehicles, registration, \$2; operators, including owners, \$2; dealer's license for each machine demonstrated, \$2.

Progress Report

The extent of streets and roads in the District on June 30, 1914, and June 30, 1915, was:

<i>Pavements</i>	<i>1914 miles</i>	<i>1915 miles</i>
Asphalt.....	151.60	154.54
Asphalt block.....	31.38	30.17
Granite block.....	25.58	25.24
Cobble.....	4.12	3.98
Vitrified block.....	1.34	1.34
Bituminous concrete.....	6.16	7.26
Cement concrete.....	1.66	3.00
Bituminous macadam.....	4.36	4.36
Waterbound macadam.....	117.76	118.98
Gravel and dirt roads.....	166.03	161.42
Total.....	<u>509.97</u>	<u>510.19</u>

Highway Officials

Engineer Commissioner in charge of all public work, Col. C. W. Kutz, U. S. A.; surface division is in charge of Capt. J. J. Loving, U. S. A., assistant to the engineer commissioner; engineer of highways, C. B. Hunt.

Road Funds

About \$264,000 is available for the current fiscal year for construction and maintenance of suburban roads.

Publications

Engineer Department

Annual Reports.

Report of the Operations of the Engineer Department, 1899-1900 to 1914-15.

FLORIDA

State Aid Legislation

A State road department, created by the legislature of 1915, was organized October 15, 1915, consisting of five members, who will serve 4-year terms, except for three of the first members. They receive no compensation, but are paid their actual expenses. The headquarters of the department is in Tallahassee, Florida. The State does not grant financial aid to road construction.

The State road department is authorized to employ a State road commissioner, who is required to be "a competent and efficient road builder and well versed in the building of good roads." He is required to visit the several counties and inspect their roads and methods of construction. Where county commissioners request the advice of the department in the construction or repair of roads, the department is required to send the road commissioner or an assistant into the county to render all assistance practicable, without expense to the county.

The law creating the department provides: "In all cases where the department shall learn that road repair or construction work is being improperly or extravagantly done, or improper or inferior materials are being used in such work, in any county, so as to cause a loss or waste of public funds, it shall be the duty of the department to notify the county commissioners of the same, and point out to them the defects discovered, and if, after such notice is given, the county commissioners continue in the use of such improper methods or materials, the matter shall be reported to the governor by the department."

The department is maintained by a special fund derived from 15 per cent of all county licenses upon automobiles and other motor-driven vehicles, this amount being remitted by the counties to the State treasurer.

Local Road Legislation

Jurisdiction over roads vests in elected boards of county commissioners, who appoint three road trustees annually for each road district. Road taxes may be worked out. Special road and bridge districts may be created by election, but the special taxes are levied and collected by the county boards. When the electors vote to make their road district a special tax district, they elect at the same time three trustees to supervise the road work.

Wide-tire ordinances are operative only where adopted by county officials.

Local Bond Legislation

Upon a petition of 25 per cent or more of the registered voters or freeholders residing in any territory embraced wholly or in part

in one or more road districts, praying that this territory shall constitute a special road and bridge district for the purpose of improving roads and bridges therein by the levy and collection of special road and bridge taxes or by the issue and sale of bonds, the board of county commissioners shall order an election thereon, and a favorable majority vote shall be necessary to authorize this arrangement. If, at this election, bonds are authorized to pay for such improvement, the board of county commissioners shall issue and sell these bonds and levy an annual tax to pay the interest and create a sinking fund for their redemption.

Convict Labor Laws

The county commissioners may employ all convicts in jail under sentence for crime at labor upon the streets of cities and towns or upon roads, bridges and public works; or the board may hire out convicts. Colored male State prisoners are subject to road work if leased to the boards of county commissioners of the various counties, who, under Acts of 1913 and 1915, have the preference over private lessees. First-grade prisoners (that is, able-bodied men) are leased to the counties at the rate of \$10 per month, and third-grade prisoners at the rate of \$1 per month. By third-grade prisoners is meant those whose physical condition does not permit them to work in a turpentine camp, but who are capable of performing reasonable labor on the public roads; it also includes all able-bodied colored male State prisoners who have actually served 10 years or more of their sentence.

Automobile Registration

The license fees for motor cars and trucks, established by an Act of 1915, are based upon the seating or carrying capacity of the vehicle, as follows:

NUMBER OF PASSENGERS	PRIVATE USE	FOR HIRE
One or two.....	\$3	\$10
Three, four or five.....	5	20
Six to ten inclusive.....	10	30
Eleven to twenty inclusive.....	15	40
Over twenty.....	25	60
CARRYING CAPACITY		
1000 pounds or less.....	\$10	\$15
1000 to 2000 pounds.....	20	30
2000 to 3000 pounds.....	30	40
3000 to 5000 pounds.....	40	50
Over 5000 pounds.....	50	60

All motor cycles pay a license of \$2.

Highway Officials

Ed. Scott, Arcadia, chairman; F. O. Miller, Jacksonville; W. J. Hillman, Live Oak; J. D. Smith, Marianna; M. M. Smith, Orlando; secretary, J. D. Smith; assistant secretary, J. P. Clarkson.

There are no civil service regulations applicable to road officials.

[Approved by J. P. CLARKSON, Assistant Secretary.]

GEORGIA*State Aid Legislation*

Georgia has no State highway department and grants no State aid in the form of money. State convicts are employed on county roads, as described hereafter. A bill for a State highway commission failed in the last legislature on account of pressure of other business.

Local Road Legislation

Jurisdiction over roads vests in elected boards of county commissioners, who divide the counties into districts, each having one or more overseers. Road taxes are worked out.

Convict Labor Laws

Convicts guilty of misdemeanors may be sentenced to work in the chain-gang of the county. All felony convicts except such as are required by law to be kept at the State farm may be employed in the several counties. On or before February 10 annually, the prison commission shall communicate with the county authorities and ascertain those counties desiring to use convict labor. Convicts shall be apportioned according to population. In 1914, 7056 convicts were used on road work.

Highway Officials

Georgia has no State highway department but the geological survey collects and publishes data on roads. Dr. S. W. McCallie is the State Geologist.

State prison commission has authority over convict labor, which is utilized for road improvement. Mr. R. E. Davidson, Atlanta, is the chairman of the commission.

Automobile Registration

The law provides for annual registration with the secretary of State. Registration fee for all motor vehicles is \$5. The net

revenue from registration is paid into the State treasury and credited to the State road fund. The said fund is apportioned to the several counties in the State in proportion to the number of miles of rural mail route in such counties.

County commissioners or ordinaries are required to ascertain by actual measurement the mileage of rural mail routes traveled in the county and to report same to the secretary of state. Any county misrepresenting the facts, or in which as many as 10 per cent of the motor vehicles therein are not returned for taxation, shall forfeit its right to share in the distribution of said fund for that year. (Act No. 478, Laws, 1910, as amended by Act of August 19, 1913; Act No. 431, Laws 1914.)

Progress Report

The following data regarding roads in 1914 were collected by the State Geological Survey and the U. S. Office of Public Roads and Rural Engineering in 1915: Total mileage of public roads, 99,606; miles of sand-clay and top-soil roads, 11,923; macadam roads, 321; chert and gravel roads, 1173; other surfaced roads, 167; improved earth roads, 38,268; unimproved earth roads, 47,754.

In 1914 the total revenue for Georgia roads and bridges was \$6,342,377, made up of the commutation tax of \$708,285, the property tax of \$2,827,353; the automobile license fund of \$92,739, bond issues of \$68,000, and \$2,646,000 of convict labor, estimated at \$1.25 per day. This is equivalent to about \$63.67 per mile of public roads or \$2.43 per capita.

Publications

Geological Survey

Bulletin 8. A preliminary report on roads and road building materials of Georgia (1901). S. W. McCallie.

Bulletin 24. A second report on the public roads of Georgia (1910). S. W. McCallie. (First report, Bulletin 8.)

Bulletin 28. A third report on the public roads of Georgia (1912). S. W. McCallie.

Georgia University. State College of Agriculture.

Bulletin, vol. 9, no. 5. Good roads for Georgia.

State Prison Commission.

Annual Reports, thirteenth to sixteenth, 1909-10 to 1912-13.

[Approved by S. W. McCallie, State Geologist.]

HAWAII

State Aid

The territory of Hawaii has done considerable construction of roads since 1911, through commissions appointed by the governor in each county. It has also constructed roads in opening up tracts of land for homesteads. All other roads are under the jurisdiction of the five counties.

Road Funds

There is a vehicle tax of \$1 on bicycles, \$2 to \$5 on carriages and carts, and 1 cent a pound on automobiles, all paid into the county road fund. There is also a road poll tax of \$2.

During 1914-15, the territory spent out of loan funds for road construction, \$59,483, and out of the proceeds of sales of public lands, \$126,967 for homestead roads. Counties are authorized to issue bonds for public improvements but have not done so.

Officials

Governor, L. E. Pinkham; superintendent of public works, C. R. Forbes; surveyor, W. E. Wall. Offices, Honolulu.

IDAHO

State Aid Legislation

The original highway department was created by the 1913 legislature. The 1915 legislature passed a bill recreating the State highway department. The State highway commission now consists of three members, two of whom are civilian members appointed by the governor, and the third member is the secretary of State, who is ex-officio secretary of the commission. The engineering department is under the direction of a State highway engineer appointed by the commission. The construction work is carried on by the State in conjunction with the counties and highway districts. In all counties, and in highway districts with an assessed valuation of over \$1,000,000, the State pays one-third the cost of highway construction, and the county or highway district the balance. Where the assessed valuation of a highway district is less than \$1,000,000, the cost of construction is divided equally between the State and highway district. All location surveys, estimates, etc., are made at the expense of the State. All contracts are let by the State highway commission and the work is done under the direction of the State highway engineer. After the completion of the roads, they are maintained at the expense of the State.

Local Road Legislation

Jurisdiction of roads vests in boards of county commissioners, elected, who divide their counties into districts and appoint one or more overseers for each.

The wide-tire law is operative unless suspended by a county board.

Bond Legislation

There are in Idaho two classes of road districts that are authorized by law and may issue bonds. Since 1905 it has been lawful for any portion of a county containing twenty-five or more resident taxpayers, by a majority vote of the resident freeholders at an election ordered by the county board of commissioners and petitioned for by a majority of the freeholders, to organize and become a good roads district. Three good roads commissioners are also chosen at this election, who are authorized, with the consent of two-thirds of the qualified freeholders expressed at an election, to issue bonds in any amount not exceeding 25 per cent of the assessed real property valuation in the district, and the proceeds must be used exclusively for road purposes. These bonds shall bear interest not to exceed 6 per cent, shall run for not more than twenty years, and shall not be sold for less than par.

Under an act of 1911, fifty or more freeholders of lands wholly within a county aggregating 20,000 acres or consisting of less contiguous territory that has an assessed valuation of \$1,000,000, provided that these freeholders own at least 10 per cent of all the property in the proposed district, or a number of resident freeholders equal to 20 per cent of the last vote cast for governor may petition the county board of commissioners for an election at which the majority vote decides. If the vote is favorable, a highway district is organized with three highway commissioners, with terms of four years each, and the first of these commissioners are appointed by the governor, while their successors are elected. The commissioners constitute a highway board and have authority by resolution to issue coupon bonds for road purposes at not exceeding 6 per cent interest, and payable within twenty years by sinking fund provided therefor. If these bonds increase the outstanding bonded debt of the district, the resolution shall provide for an election, and a two-third vote is necessary to carry the election. In highway districts the amount of the bond issue shall not exceed 10 per cent of the assessed valuation of all property in the district.

A good roads district may become a highway district in the same manner as any unorganized territory.

Convict Labor Laws

The highway commission is authorized to make requisition upon the warden of the State penitentiary for convicts for road labor, subject to such rules and regulations as the board of prison commissioners shall prescribe. The warden and prison commission shall assign such prisoners as they deem physically able and at the same time reasonably safe to work on the State roads under the general direction of the highway commission.

Automobile Registration

The law provides for annual registration with the secretary of the State highway commission. The schedule of fees is as follows: 30 h.p. or less, \$15; 31 to 40 h.p., \$20; 41 to 50 h.p., \$25; 51 h.p. and over, \$40.00; motor cycles, \$5.00; dealers and manufacturers, \$35.

Motor vehicle licenses are collected by the assessors of the various counties. The counties retain 75 per cent of the fees to be used on the county roads, after deducting enough to pay the interest on any road bonds which may be outstanding. The remaining 25 per cent is forwarded to the State treasurer who deducts 10 per cent of this amount to pay the interest on outstanding State highway bonds, and the balance is used for State highway maintenance.

Highway Officials

The State highway commission consists of W. A. Brodhead, chairman; E. A. Van Sicklin, vice-chairman, and George R. Barker, ex-officio, secretary. The State highway engineer is E. M. Booth, Boise.

Progress Report

During 1915 about 220 miles of State highways were completed, and about 240 miles more will be completed in the spring of 1916. About 40 miles of sand-clay or gravel roads are included in the 220 miles. This work involved an expenditure of \$153,300 of State funds and \$306,600 of county funds.

Road Funds

There is \$50,000 of State funds available for State road construction in 1916, and \$300,000 of county funds to be spent under the direction of the State highway department. The 1915 legislature made no appropriation for road work.

Publications

State Highway Commission; report for 1913-14.

[Approved by E. M. Booth, State Highway Engineer.]

ILLINOIS

State Aid Legislation

All roads or bridges built, repaired or improved at the joint expense of the State and one or more counties are termed "State Aid Roads" and the money appropriated by the State for such purposes is termed the "State Road and Bridge Fund." A State highway commission of three members, one appointed by the governor every two years and each serving six years, has general supervision of State aid roads, prescribes the regulations governing the State highway employes and the county highway superintendents, aids the county highway superintendents and town and district highway commissioners in establishing grades and drainage systems and the general construction and maintenance of roads and bridges, studies the various methods of meeting the road and bridge requirements of all parts of the State, has the final approval of final plans, specifications and estimates of State aid roads, and lets all contracts for their construction or improvement.

The administrative and technical agents of the commission are a chief State highway engineer and an assistant State highway engineer, appointed by the governor for a 6-year term. They also act as technical advisers to county, township or road district officials.

The State pays one-half the cost of State aid roads and the counties the other half. A majority of the entire county board may specify the type of construction of a road built under the State aid laws, "which decision shall be final and not subject to change by the State highway commission, whether of permanent earth improvement (including surface or sub-surface drainage, grading, leveling and crowning), gravel, macadam, concrete, concrete and macadam combined, or brick. The final decision must not be made until the board has obtained from the State highway commission detailed estimates of the cost of the different types and has published them in two county newspapers. In case a board cannot agree on a type of construction or does not care to choose, the State highway commission specifies the type. When a type has been selected it "shall be adhered to throughout the entire length of such road, that is, from one main objective or connecting point to another within the county." The State and county may, however, jointly change an earth, gravel or macadam type of road to a more permanent one at any time. One-half the maintenance expense of a gravel or macadam State road must be paid by the county and the entire maintenance expense of an earth road.

In preparing estimates, the State highway commission may require to be included the value of any materials or the fair rental of any equipment which the State is to furnish. The State highway engineer may call upon county highway superintendents for aid in preparing the plans, specifications and estimates. The estimates must include cost of land obtained by private agreement or condemnation proceedings.

No contract for a State aid road can be signed until the money to pay the State's half of the cost has been paid into the State road and bridge fund.

Local Road Legislation

In each county there is a county highway superintendent, appointed by the county board after a competitive examination for the place held by the State highway commission, preference being given to a resident of the county. No part of the State road and bridge fund may be apportioned to a county until it has appointed such a superintendent. His term is 6 years and he is regarded as a deputy to the State highway engineer. In case the office is vacant and a temporary emergency requires some qualified official to discharge the duties, the State highway engineer may appoint somebody to perform these duties temporarily.

The county highway superintendent prepares the plans, specifications and estimates for all county bridges, subject to their final approval by the State highway commission, supervises the construction and maintenance of all roads and bridges under exclusive county control or joint county and town or district control, makes at least one inspection annually of each road or bridge in the county, and as many more as the State highway officials direct, advises the town or district highway officials on the maintenance and improvement of roads and bridges, and supervises the maintenance of State aid roads in the county under the direction of the State highway commission.

The supervisors of a county under township organization or the commissioners of a county not so organized had the original right to designate the roads to receive State aid. These were required to be "as nearly as possible those highways connecting the principal cities and trading points in each county with each other, and also with the principal cities and trading points in other counties." These routes were then examined by the State highway commission, and changes desired in them were submitted to the county officials, who appeared before the commission, of they wished, to discuss the changes. The State highway commission made the final selection of the routes, after this hearing. In case the county officials failed to select routes within 6

months of the passage of the law, the State highway commission was authorized to make the choice.

The control of local roads is exercised in two ways. In counties not under township organization, the county boards divide the territory into road districts which are the local administrative units for highway purposes exclusively. In counties under township organization, the several towns have authority over the roads. In either case, the roads are in charge of a highway commission of three members serving three-year terms. The local road tax rate of a town or district is determined by its commission annually. Any contract for construction, machinery or materials exceeding \$200 must be approved by the county highway superintendent. One of the unusual requirements of the law makes it the commission's duty "to prevent thistles, burdock, cockle-burs, mustard, yellow-dock, Indian mallow and jimson weed from seeding, and to extirpate the same so far as practicable." Any town or road district may substitute by vote a single highway commission for a board of three commissioners.

Road Funds

The annual allotment of State road funds to a county bears the same ratio to the whole appropriation that the total road and bridge tax of the county does to the sum of such taxes in all counties, except in counties where over 40 per cent of the total amount appropriated for roads by the legislature is collected, including automobile licenses, the allotment of State funds shall equal 25 per cent of the amount so collected in each of the counties. State aid is not permitted to exceed half the cost of an improvement. A county which does not appropriate within 6 months of the date of the State allotment at least an equal sum, forfeits its allotment, which is distributed among the counties fulfilling the law.

If a county desires to construct a State aid road more rapidly than funds can be provided in the manner just indicated, the law authorizes the county to advance the necessary funds and construct the road at any time. In this case, any allotment of State aid funds may be used either to defray half the cost of new roads or to pay off county bonds or other obligations issued to construct State aid roads at the county's expense, provided the total State aid used in the latter way does not exceed half the cost of constructing such roads, which must comply when finished with the plans, specifications and estimates of the State highway engineer. Bonds so issued must be specifically authorized by a majority vote of the electors and must mature in not less than 10 nor more than 20 annual series.

There is an annual highway poll tax of \$1 to \$3 in each town

or road district, payable to its treasurer by every able bodied male resident, unless this form of taxation for local roads is abolished by vote of the electors of the town or district. The property tax for local highway purposes must not exceed 61 cents on each \$100 valuation plus an allowance of not over 20 cents per \$100 to pay for property damages incident to road improvements. Towns and road districts may issue bonds to pay for road and bridge improvements. Not less than \$3 or more than \$5 per mile per annum of the road funds of a town or road district must be used for dragging earth roads.

Convict Labor Laws

Prior to 1915, convicts were not worked outside prisons except in quarries getting out rock for State use. Crushed rock and other road material produced by convict labor is furnished free at the penitentiary where prepared to the State highway commission for permanent road improvements. In 1915 convicts were worked on local roads on requisition from town highway commissioners, a charge of 50 cents per man per day being made for board. Three or four convict camps were worked and about 25 miles of macadam road constructed by them.

Automobile Registration Laws

The law provides for annual registration with the secretary of State. The schedule of fees is as follows: 25 h.p. or less, \$4; 26 to 35 h.p., \$6; 36 to 50 h.p., \$8; over 50 h.p., \$10; all electric motor vehicles, \$5; motor cycles, \$2; manufacturers and dealers, \$15; chauffeur's license, original, \$5.

Registration revenues are paid into the State treasury and credited to the State road fund for expenditure only in the construction of permanent roads. Fines and forfeitures are paid into the treasury of the road district, town or city in which collected and credited to the road fund. (Chapter No. 121, Code of 1912, as amended by Act of June 28, 1913.)

Highway Officials

State Highway Commission.—A. D. Gash, president; S. E. Bradt, secretary; James P. Wilson. Chief State highway engineer, Wm. W. Marr; assistant State highway engineer, P. C. McArdle, on leave of absence as highway engineer of Vermilion county; road engineer, H. E. Bilger; bridge engineer, C. Older; B. H. Piepmeier, maintenance engineer; F. L. Roman, testing engineer; chief clerk, J. M. McCoy.

With the exception of the State highway commission, chief State highway engineer and assistant State highway engineer, all persons employed on State road work are subject to the Illinois civil service laws.

Progress Report

Under the State aid system which became operative July 1, 1913, there were completed and accepted up to January 1, 1916, 115.131 miles of State aid roads. Of this amount there are 53.963 miles of concrete roads 10 feet wide, 5.333 miles 15 feet wide, 29.405 miles 18 feet wide and 1.809 miles of variable width; 15.677 miles of brick roads 10 feet wide, 3.320 miles 18 feet wide and 3.428 miles of variable width; 1.136 miles of gravel roads, and 1.060 miles of macadam roads; and 81 State aid bridges. The total cost of the work was \$1,497,407, of which sum the State furnished half.

Road Funds

The 1913 legislature appropriated \$400,000 for 1914 and \$700,000 for 1915, and like amounts were raised by the counties. The 1915 legislature appropriated \$1,000,000 for the year beginning July 1, 1915, and \$1,000,000 for 1916-17. Of the amount appropriated for 1915-16, \$10,000 was set aside for maintenance.

Cook County has issued \$2,000,000 road bonds, the proceeds available after July 1, 1916. Vermilion County has issued \$1,500,000 and Clark County has issued \$350,000. There are 28 other counties contemplating road bond issues. The total amount of such bonds to be issued within two years is estimated at \$30,000,000.

As a result of the changes made in the road laws in 1915, giving the counties the privilege of designating the type of construction for a new State aid road, there was a great increase in the mileage of earth roads to be constructed. Prior appropriations had been utilized in preparing for building 1 to 5 miles of more durable types of road in each county. Under the changed conditions, surveys, plans, specifications and supervision are required for between 1000 and 1500 miles of improvement instead of the 100 to 200 miles proposed when the funds for administrative purposes were contemplated. When these notes were prepared it was hoped that an emergency appropriation would be made to cover these unforeseen additional charges.

*Publications***Agricultural Experiment Station**

Bulletin 65, 1901. Road construction and maintenance.

Highway Commission

Annual Reports from 1906 to 1912 (1906 and 1908-1909 out of print).

Bulletin 1. Earth road drag, how to make it and how to use it (out of print).

Bulletin 2. Road drag law and rules for dragging.

Bulletin 3. How to secure bridge plans. Information for county, township, and municipal officers.

Bulletin 4. Crushed stone prepared by convict labor and rules for its use (out of print).

Bulletin 5. General rules and regulations (out of print).

Bulletin 6. Modern bridges for Illinois highways (out of print).

Bulletin 7. Township hard road law (out of print).

Bulletin 8. Manual of Instructions to engineers.

Bulletin 9. Modern bridges (which is a revision of bridge bulletin No. 6.)

Under the present State Highway Department, the following publications have been issued:

Bulletin 1. Qualifications for county superintendents of highways.

Bulletin 2. Information for county boards.

Bulletin 3. Policy of the State highway commission.

Bulletin 4. Crushed stone prepared by convict labor and macadam roads built without a roller.

Bulletin 5. Synopsis of the Illinois Road Law. Rules and regulations of the Illinois highway commission applying to bridge design.

Bulletin 6. Dust Prevention.

Bulletin 7. Fiscal regulations for State highway departments.

Bulletin 8. Manual of instructions to engineers.

Bulletin 9. Modern bridges.

Bulletin 10. Bridge manual for county superintendents of highways, resident engineers and inspectors.

Bulletin 11. Surface oiling of earth roads.

No number. Report to governor for 1913-1914.

State Geological Survey.

Bulletin 9. Paving brick and paving brick clays of Illinois (1908).

Illinois University. Engineering Experiment Station.

Bulletin 65. Construction and care of earth roads. Ira O. Baker.

Illinois Highways, Monthly Bulletin.

[Approved by Wm. M. MARR, Chief State Highway Engineer.]

INDIANA*State Aid Legislation*

The State has no highway department and does not grant aid in any form toward road construction and maintenance.

Local Road Legislation

Three county commissioners in each county, one commissioner elected in November of each year, have supervision over roads. They are also ex-officio a board of directors for all free gravel,

macadam and turn pike roads and shall appoint a county highway superintendent for 2 years. They also appoint superintendents of construction for gravel roads built by assessment of contiguous property.

Boards of township trustees elected in November every four years divide the township into road districts and a supervisor is elected every odd year in December in each road district.

The county highway superintendent shall appoint assistant superintendents not to exceed four for each 100 miles of road. The county highway superintendent shall have general supervision of the maintenance and repair of all county highways, bridges and culverts.

Bond Legislation

County commissioners are authorized, when requested by a petition signed by fifty freeholders, to grade, drain and pave with "stone, gravel or other road paving material" new or existing highways in any township or on the line dividing two or more townships, and to issue 5 per cent county bonds not to exceed the contract price of the improvements, nor in excess of 4 per cent of the assessed valuation of the town or townships including bonds already issued. The bonds must be in denominations not less than \$50 and payable in semiannual series in not less than ten nor more than twenty years. The bonds are retired by an annual tax levied by the commissioners on all the property of the townships affected. Complete plans and specifications for all improvements are made before the election is ordered by a competent civil engineer and two viewers appointed by the commissioners.

For the same purposes as above, gravel road assessment bonds may be issued by county commissioners when petitioned by a majority of the resident landowners within one mile of the proposed improvement. The bonds are paid off by assessment upon the property in proportion to the benefits derived from the improvement.

For the purchase of toll roads, the county commissioners may issue bonds not exceeding 4 per cent of the payable assessed valuation in annual series for not more than twenty years, and bearing interest not exceeding 6 per cent.

All highway bonds bearing interest not exceeding 4½ per cent are exempt from taxation.

Convict Labor Laws

The managing boards of the State reformatory and State prison may, wherever there is no work for the inmates within the prison, arrange with the county commissioners or township trustees for working the convicts on the roads.

Automobile Registration

The law provides for annual registration with the secretary of State. The schedule of fees is as follows: 25 h.p. or less, \$5; 26 to 40 h.p., \$8; 41 to 50 h.p., \$15; over 50 h.p., \$20; electric pleasure vehicles, \$3; all commercial vehicles, \$5; motor cycles, \$2; manufacturers and dealers, \$25; chauffeur's license, \$2.

The net registration revenue is paid into the State treasury and credited to "a road fund" which shall be apportioned to the several counties on January 1 and July 1, of each year. Fines and forfeitures are paid into the State treasury and credited to the same fund as the registration revenues. (Chapter No. 300, Laws 1913.)

Progress Report

During the winter and spring of 1914 several farmer, road and civic organizations petitioned the governor to appoint a voluntary highway commission to study the virtues and defects of the Indiana system and report to the legislature to meet in January, 1915. Accordingly, in June, 1914, Governor Ralston appointed a commission of five executive and thirteen advisory members. This commission held public hearings in twelve of the thirteen congressional districts of the State and gathered much information. A report was submitted to the governor and legislature, recommending a State highway board and engineer, State control of main roads and a certain amount of State aid. A bill embodying these recommendations was passed by the State senate but failed of passage in the house. Indiana therefore remains one of the few States without some State board or engineer, or some form of State control of the main public roads of the State.

(Approved by CLARENCE A. KENTON, Indianapolis, Ind.)

IOWA*State Aid Legislation*

By the act of the thirty-fifth general assembly, a State highway commission was created in Iowa with much more power than the former commission. Two members of the commission are appointed by the governor from opposite political parties and the dean of engineering at the Iowa State College is the third member.

The highway commission is charged with the supervision of the road and bridge work of the State. This work is in direct charge of the county and township officers assisted by the county

highway engineer. The township officers have charge of construction and maintenance of the township road system which embraces about 85 per cent of the mileage of the county. The county officers build all bridges and culverts and have charge of the county road system made up of those roads not in the township system. The county system, made up of those roads which connect the trading points and the adjoining county systems but not to exceed 15 per cent of the entire mileage of any county are the main traveled roads and constitute a complete network of roads covering the State.

All bridge and culvert work must comply with the highway commission standards. Contracts for single structures costing over \$2000 must be approved by the highway commission. All plans for permanent road grading, drainage, and surfacing must be approved by the commission. Standard plans and profiles are made for each mile of road so improved.

A feature of the law is the resolution of necessity required to be published to inform the public of the intention to build structures costing over \$300. This resolution must describe the location of proposed structure, dimensions, drainage area, material of construction, and estimated cost of all contemplated work.

Local Road Legislation

Jurisdiction over roads vests in county boards of supervisors and in township trustees, subject to general supervision by the State highway commission. Road taxes are worked out. A rebate of part of the property road taxes is granted to those complying with the wide-tire law.

Convict Labor Laws

State convicts may be worked at stone quarries, and the crushed stone produced, furnished to counties, townships, or road districts, f.o.b. cars at crushing plant.

The highway commission experimented again in 1915 very satisfactorily with 50 to 75 convict laborers on road, bridge and culvert building. They were paid 20 cents per hour, out of which they paid the entire expense of their camp and of the single guard in charge of the men. They dressed like ordinary workmen. They were willing and intelligent workmen and better results in some respects were secured than with ordinary labor.

Automobile Registration

The law provides for annual registration with the secretary of State. The schedule of fees is as follows: 20 h.p. or less, \$8; each

additional h.p. over 20 h.p., \$.40 additional; all electric and steam vehicles, \$15; motor cycles, \$3; manufacturers and dealers, \$15.

Five per cent of the gross revenue is set aside in the State treasury as a maintenance fund for the State highway department. Ninety per cent of the gross revenue is apportioned to the several counties of the State for expenditure only for crowning, draining, dragging, graveling or macadamizing public roads outside of incorporated towns or cities.

Highway Officials

State Highway Commission—Prof. A. Marston, J. W. Holden and H. C. Beard. Highway engineer, Thos. H. MacDonald; road engineer, F. R. White; bridge engineer, J. H. Ames.

Progress Report

The total mileage of all the roads in Iowa outside of incorporated towns and villages, is 104,017. The estimated total mileage of roads, including city pavements, improved by hard surfacing is 500. Included under this heading would be classified all roads that have macadam, concrete, or brick surfacing. At this time there are, to our knowledge, only 7 or 8 miles of concrete roads in this State outside the limits of incorporated cities and towns. The estimated amount of 500 miles does not include probably 500 miles of the roads in the State which have been graveled. This can hardly be called hard surfacing and for this reason has been omitted from this classification.

There is no law in this State which allows the State to bear a portion of the expense for the construction and maintenance of the highways. At present this work is carried on entirely by the townships and the counties. Under the law enacted by the 35th and 36th general assemblies of this State all of the roads in the State are under the general supervision of the State highway commission. A division is made in each county into townships and county roads. The county constructs and maintains the entire county road system which is composed of not less than 10 per cent and not more than 15 per cent of the total mileage of the county. These roads included in the county system have been designated as county roads and the township officials have no authority over them. The remainder of the roads in the townships outside of the limits of incorporated cities and towns are under the supervision of the local township officials, namely, the township trustees and road superintendents.

The thirty-sixth general assembly provided a maintenance fund consisting of 5 per cent of the motor vehicle tax for the general

expenses of the State highway commission. This is the only expenditure made by the State towards road improvement at this time. Previous to April 9, 1913, the date when the present law went into effect, the work of the commission was carried on as a department of the State college under an appropriation of \$10,000 per year. During 1915 the amount available for the use of the commission was \$85,000.

A change was made under the present laws whereby the supervisors of each county were required to appoint a county engineer who has general charge of the road and bridge work throughout the county. Under the present law all of the bridges regardless of size or location excepting those inside the cities and towns, are built and maintained by the county board of supervisors under plans and specifications issued by the commission.

During 1915 the commission has prepared special plans and designs for over \$1,500,000 worth of bridges and culvert work. Standard plans have been issued for a number of the general types of highway bridges used by the State as well as standard cross sections for the road work. At present there is a growing sentiment in favor of surfacing the main traveled highways. Four miles of concrete roads and 22 miles of gravel macadam have been built. Many miles of cheaper gravel roads have been built in counties where gravel is readily available. There have been numerous very satisfactory experiments in oiling dirt roads.

Road Funds

Estimated amount of money available for road improvement during 1916, including culverts and bridges: State appropriation for highway commission, \$85,000; auto tax distributed by the State, \$1,500,000; township road fund controlled by township trustees, \$3,000,000; township drag fund controlled by township trustees, \$950,000; county road fund controlled by county supervisors \$3,300,000; county bridge fund controlled by county supervisors, \$3,500,000; total, \$12,335,000.

The above are all cash taxes. There is in addition roughly \$500,000 available from labor taxes.

Publications

State Highway Commission.

Annual reports 1904-05 (out of print).

Manual for Highway Officers, 1905-06 (out of print).

Bulletin, vol. 3, no. 1. Road and Bridge Improvement in Iowa, 1908.

Service Bulletin no. 1. June edition. (A summary of the Iowa road laws.)

Service Bulletin no. 2. Standard Specifications for Concrete Reinforcement Bars.

- Monthly Service Bulletin. Published monthly beginning December, 1913.
Supplement to vol. II, no. 1, Monthly Service Bulletin. Standard Specifications for Highway Bridge Construction.
Standard concrete superstructures for steel and concrete bridges.
Standard deck girder superstructure.
Standard three girder.
Standard riveted low truss with concrete floor, with joists.
Standard riveted low truss with concrete floor, without joists.
Concrete box culverts.
Concrete slabs.
Circular culverts.
Metal culvert headwalls.
Piling abutments for steel superstructures.
Wood pile bridges.
Iowa State College. Engineering Experiment Station.
Bulletin, vol. 2, no. 6. The good roads problem in Iowa. Iowa State Highway Commission.
Engineering Experiment Station, Iowa State College.
Bulletin 28. Road Legislation and Administration, October, 1912.
Service Bulletin, published monthly.
Standard specifications for highway bridges.
Standard specifications for building earth roads.
Standard specifications for concrete road building.
Standard plans for low riveted steel trusses.
Standard specifications for metal culverts.
Report on test specimen concrete tile.
Engine loads on timber joists.
Accredited paints for shop and field coats.

[Approved by State Highway Commission.]

KANSAS

State Aid Legislation

The State grants no money aid for road improvement, but the office of State engineer has been established at the Kansas State agricultural college for the purpose of giving advice throughout the State in connection with the construction and maintenance of roads and bridges, drainage, and irrigation. The appropriation is about \$11,000 per annum.

Local Aid Legislation

Jurisdiction over State and county roads vests in boards of county commissioners. They must appoint county engineers or designate the county surveyors as county engineers to have charge of all bridge and road work under the commissioners. Township roads and mail routes are under the trustee, clerk and treasurer of each township, who may appoint one or more overseers to superintend construction and maintenance.

Road Bond Legislation

Upon petition of 60 per cent of the landowners who own at least 50 per cent of the land to be taxed, naming the road, the terminal points of improvement, the kind of improvement, and the number of assessments, not exceeding ten, to be made in payment thereof, the county board shall improve this road if it is found and declared to be of public utility.

The county commissioners are empowered to make contracts. In payment for any work or material, these commissioners shall issue special improvement bonds, bearing interest not exceeding 6 per cent and payable within the time or times mentioned in the petition.

Three-fourths of the cost of the improvement shall be apportioned among the property owners within the radius described in the petition and shall be collected as other taxes. One-fourth shall be charged to the township or townships in which the improvement is made and this amount shall be raised in the same manner as provided by law for raising taxes for all purposes. The county must pay for all engineering and superintendence and for all bridges and culverts costing more than \$200 and it may pay any part of the total cost of the improvement that the commissioners may determine. Provided that this act does not apply to the construction or improvement of roads costing less than \$500 per mile.

Bridge bonds in any sum not in excess of 1 per cent of the taxable property may be issued by the board of county commissioners of any county, the mayor and council of any city, and the trustee, clerk, and treasurer of any township, upon a majority vote at an election called by a petition signed by two-fifths of the voters of their respective political division.

The bonds shall be in denominations of not less than \$100, shall bear interest not exceeding 10 per cent, and shall run for not less than five, nor more than thirty years.

Convict Labor Laws

Convicts may be employed on the roads on payment of \$1 per day per man, plus all additional expenses of guarding them.

Automobile Registration

The law provides for annual registration with the secretary of State. The schedule of fees is as follows: All motor vehicles, \$5; motor cycles, \$2; dealers shall register one in each class at regular rates.

The net revenue is paid into the county treasury of the county in which collected for expenditure only in maintenance of the designated roads. (Act of March 12, 1913.)

Highway Officials

The State engineer is appointed by the board of administration of the State Agricultural College, Manhattan. W. S. Gearhart, Manhattan, is State engineer.

[Approved by W. S. GEARHART, State Engineer.]

KENTUCKY

State Aid Legislation

By an act passed in March, 1912, the governor was required to appoint on July 1, 1912, and every four years thereafter a State commissioner of public roads, who shall be a graduate in civil engineering from some reputable university or some technical college and have had at least five years' experience in civil engineering. The expenditures chargeable to the State road fund were limited to not to exceed \$25,000 per annum. The commissioner is authorized to collect and disseminate information, furnish plans, specifications, and estimates of cost of bridges and roads, but it is not obligatory on the part of local officials to accept such plans and specifications, but they must be kept on file in the office of the county road engineer, as are the plans, specifications, and actual cost. He is also required to hold an examination for the appointment of county engineers, and such county engineers shall, upon order of the State commissioner, cause all roads within their counties to be measured and shall make report to the said commissioner.

The General Assembly of 1914 passed a bill which levied a State tax of 5 cents on the \$100 of taxable wealth, which is to constitute a State road fund to be redistributed to the counties applying for aid to the extent of one-half the cost of construction or reconstruction of public roads. No county to receive in any one year more than 2 per cent of the total fund.

Also another bill was passed, making roads connecting the county seats of adjoining counties on the most direct and practical route, public State highways, to be the first to receive State aid.

Road Bond Legislation

On the petition of 150 voters and freeholders of a county, the county court shall call an election to determine whether bonds of

the county shall be issued in an amount not to exceed 5 per cent of the taxable valuation of the county. If two-thirds of the legal voters voting shall favor the issuance of bonds, the fiscal court may issue them, to bear not exceeding 5 per cent interest, to run not less than five nor more than thirty years, and to be sold for not less than par. The fiscal court shall levy an annual tax of not to exceed 20 cents on each \$100 valuation of taxable property in the county, to pay the interest on such bonds, and to create a sinking fund for their redemption at maturity. Sinking fund accumulations may be loaned by the fiscal court on first mortgage real estate security, on the basis of 50 per cent of its value.

Any county which issues bonds and expends the proceeds thereof for building public roads, under the direction of the commissioner of public roads, in an amount greater than the amount which said county may be able to secure by apportionment from the State road fund for that year, shall be entitled to receive from the State road fund in subsequent years such further amounts or apportionments as will make the total amount ultimately received from said fund equal to one-half the amount so expended by said county.

Convict Labor Laws

Prisoners sentenced to work at hard labor may be placed in the work-house, if there be one in the county, or at work upon the public works, or roads, of the county, or upon the public works of any city or town in the county. The place of working such prisoners shall be determined by the county judge, giving preference to work on roads of the county whenever the weather will permit. When placed upon the public works of any city or town, such city or town shall provide and pay for food, lodging, and guarding; and when placed on the county roads, such cost shall be paid out of the road funds of the county. The county judge is authorized to appoint a manager for each crew of prisoners, who shall also act as guard. No crew shall consist of less than three prisoners, and not more than one man shall be paid to guard and manage less than ten prisoners. The county or fiscal court shall have power to prescribe regulations for the government of prisoners and those in charge of them. All prisoners placed at hard labor shall be permitted to satisfy their fines and costs with such labor, at the rate of \$1 per day.

The State may employ State convicts outside of the walls of the penitentiary in road or bridge work, or in the preparation of materials therefor.

Local Road Legislation

The roads are under the county fiscal courts.

There is created in the several counties of the State the office of county road engineer, who is to be appointed by the county judge, by and with the consent of the fiscal court, for a term of two years. Such county road engineer shall be either a reputable civil engineer or a man who has had practical experience as a road supervisor or builder for two years and who shall have passed a creditable examination by the State commissioner of public roads or one of his representatives. (Acts of 1914, Chap. 80, Sec. 39.)

The county road engineer may be removed at any time by the county judge upon his own volition for incompetence, malfeasance or misfeasance in office, upon written charges, after a hearing of which 10 days' notice shall be given by serving a copy of such charges upon such county road engineer. (Acts 1914, Chap. 80, Sec. 40.)

Automobile Registration

The law provides for annual registration with the secretary of State. The schedule of fees is as follows: Less than 25 h.p., \$6; 26 to 49 h.p., \$11; 50 h.p. and over, \$20; manufacturers and dealers, one vehicle in each class, at regular rates.

Registration revenues are paid into the State treasury for the benefit of the State road fund. (Act of March 14, 1910.)

Highway Officials

State commissioner of public roads, Robert C. Terrell, Frankfort.

Progress Report

The department furnishes plans, specifications and estimates for all bridges over \$500 in value. It furnishes surveys, specifications and estimates for all new roads and the same for all reconstruction when requested by the fiscal courts. The department also keeps up a continuous campaign along educational lines, by mailing bulletins of road information, by displaying road models at the State fair and some of the larger county fairs, by holding road meetings over the State and by furnishing speakers for road meetings in the various counties of the State. Since the organization of the department plans, specifications and estimates for about 757 bridges have been made, surveys for about 1400 miles of new road have been made, about 4000 miles of old road has been inspected and advice furnished; 787 miles of road have been constructed under the direct supervision of the department.

The general assembly of 1914 passed a bill which levied a State tax of 5 cents on each \$100 of taxable wealth, which is to constitute a State road fund to be redistributed to the counties applying for aid to the extent of one-half the cost of construction or reconstruction of public roads. No county to receive in any one year more than 2 per cent of the total fund.

Also another bill was passed, making roads connecting the county seats of adjoining counties on the most direct and practical route, public State highways, to be the first to receive State aid.

Road Funds

In 1915, the State-aid road fund was \$750,000 and a like amount was spent by counties receiving this aid. In addition 16 counties voted bond issues of \$40,000 to \$250,000, a large part of which has been spent under the supervision of the State highway department. In 1916, the State-aid fund will probably be \$750,000, the same amount will be raised by counties for State-aid roads, and about \$3,000,000 in bonds will probably be issued for roads.

Publications

Governor's Message, 1827

State control of roads and bridges urged.

State Board of internal Improvement

Annual report, 1837. Directions for construction of turnpike roads.

Governor's Message, 1838-39

Review of history of internal improvement of the past. A large number of reports and bulletins were issued by the State Board of Internal Improvement and the Legislature regarding toll roads.

State Auditor

Biennial report, 1881-83. Statement showing number of turnpikes in which State owns stock, length of each in miles, whole number of shares of stock, number owned by State, amount per share, average per cent stock has paid for six years prior to January 1, 1882; amount of dividends paid State, cost for salaries to gate keepers and officers, and cost of repairs. 1882-1885.

State Geological Survey

Report of progress, 1886-87. Historic sketch of turnpike road and railroad building in Kentucky. 1775-1820.

Bureau of Agriculture, Horticulture and Statistics

Annual report, eighth, part 2, 1889. Conditions of public highways in Kentucky, 1889.

Bureau of Agriculture, Labor and Statistics

Biennial report, twelfth, 1895-97, Estimated number of miles of macadamized turnpikes in State; end of twelve months will probably see last of old toll system and inauguration of new system of maintenance by taxation, 1897.

Biennial report, thirteenth, 1898-99.

Biennial report, eighteenth, 1908-09, Division 4. Roads.

State Farmers' Institutes

Annual State Farmers' Institute.

First, 1906. Country roads. Address on roads.
 Second, 1907. Dirt roads, their construction and maintenance.
 Third, 1908. County roads.
 Fourth, 1909. Good roads in Kentucky.
 Fifth, 1910. Road legislation in Kentucky. McCracken County Judge.
 Report relative to public improvements, 1909.

State department of public roads, 1913

Bulletin 3. Information concerning the Office of Public Roads.
 Bulletin 4. Compilation of Kentucky road laws.
 Bulletin 5. Split Log Drag.
 First Biennial Report of the Department of Public Roads, 1913.
 Bulletin 6. Compilation of Kentucky road laws (including Acts 1914 General Assembly).
 Bulletin 7. Highway bridge lettings.
 Bulletin 8. Questions and answers. (Information concerning department and State aid work.)
 Specifications. Bridges, culverts, etc.
 Questions and answers. Examination for county road engineer.
 Second Biennial Report of the Department of Public Roads.

[Approved by ROBERT C. TERRELL, State Highway Commissioner.]

LOUISIANA

State Aid Legislation

The board of State engineers is authorized to appoint a State highway engineer, who holds office until removed for cause by the board. He is required to be a competent civil engineer, experienced in highway work. The board is authorized to appoint assistants and clerks and provide offices; to hold meetings in its discretion for considering the general policy of the department and receive the annual report of the State highway engineer. The board acts in all matters concerning recommendations, estimates, etc., to be submitted to the governor.

The State highway engineer is required to make a general highway plan of the State, collect statistics, establish standards for construction and maintenance, have supervision over construction and maintenance of State highways on which State aid has been granted, subject to the approval of the board of State engineers. He or his assistants must make all surveys, plans, specifications, and estimates and select material for such State highways. He awards contracts, but may reject any and all bids and conduct the work with his own force. He is authorized, with the approval of the board of State engineers, to purchase, for the State, road machinery, draft animals, and supplies, and loan such equipment to the parishes. Upon completion of contract for State highways the State highway engineer certifies to the State treasurer and the president of the police jury the portion to be paid by the State and parish respectively.

The State highway engineer is required to keep all roads improved as State highways in repair, the total cost to be paid by the State and the parish to reimburse the State in the same manner as for construction. He is required to organize a system of repair whereby all roads may be in good condition at all times.

The initiative in obtaining State aid rests with the police juries of the respective parishes. They make application to the State highway engineer for State aid in the improvement of main traveled roads, and the said State highway engineer must take up such applications as far as practicable in the order of their receipt, provided the parishes have raised their portion of the cost of such improvement.

In order to provide a State aid fund a general property tax of one-fourth of 1 mill, is placed in a fund known as the State highway fund. This fund is apportioned by the State highway engineer with the approval of the board of State engineers. From 10 to 50 per cent of the cost of State aid roads is apportioned to the State and 50 to 90 per cent to the parish.

Local Road Legislation

The State is divided into parishes and the roads in each parish are under its police jury.

Road Bond Legislation

Municipal corporations, drainage districts, or parishes may issue bonds for the purpose of improving the roads therein. Before these bonds are issued, the question shall be submitted to an election and a majority in number and in the amount of property valuation of the actual votes cast shall be necessary to carry the election. Bonds shall not be issued for a greater amount than 10 per cent of the assessed valuation, shall bear not exceeding 5 per cent interest, and shall run not to exceed forty years. A sinking fund shall be provided to redeem these bonds at maturity and an annual tax imposed to create this sinking fund and pay the interest on the bonds annually. Such bonds shall be sold for not less than par, and the proceeds thereof shall not be used for any other purpose than that for which they are issued.

Police juries of the several parishes are authorized to divide their respective parishes into road or sub-road districts, and the governing authorities of said districts shall have the right to issue bonds, in accordance with the general laws of the State authorizing the issuance of road bonds, to provide for the construction of the public roads therein.

Convict Labor Laws

Under the provisions of the law, the highway department, board of State engineers, has the right and power, when available, to employ state convicts for highway work. Under this system of State aid, the board of control of the State Penitentiary furnishes the convict labor, retaining such rights over them as relate to their guardianship, personal care, and enforcement of physical labor. The highway department, board of State engineers, supervises all work relative to construction, makes all surveys and locations, and outlines and puts into execution all details relative to the building of highways under this system. The police jury of each respective parish furnishes all funds for the maintenance, guarding and working of the convicts, all materials required in the construction work, and all required rights-of-way.

Automobile Registration

Annual registration of motor vehicles with the secretary of state is required, the fee being 25 cents per horse power with a minimum fee of \$5. A flat fee of \$2 is required for each motor cycle and \$7.50 for each motor truck. The proceeds from the registration of motor vehicles is to be paid to the various parishes from which collected and apply to the construction and maintenance of roads. Non-residents are exempt if like exemption is granted residents of Louisiana. The act was submitted to a general election in 1914 and ratified and became effective January 1, 1915.

Highway Officials

The board of State engineers of Louisiana, of which the highway department is a branch, is composed of the following members: F. M. Kerr, chief state engineer, Gervais Lombard, J. W. Monget, Marshall P. Robertson, John Klorer.

The officers of the highway department of the board of State engineers, are: F. M. Kerr, chief State engineer, and president of the board of state engineers; W. E. Atkinson, State highway engineer; Chas. M. Kerr, assistant State highway engineer; Chas. F. Wood, secretary, New Orleans.

Progress Report

During 1915, the highway department, board of State engineers, extended State aid to 14 parishes for the construction of 15 highway projects aggregating 145.8 miles, of which 2.5 are shell roads, 94 miles gravel, and 49.3 improved earth. The estimated cost of

construction is \$500,000, the State contributing approximately \$100,000, and the parishes the remainder.

State convicts were not employed during 1915 in the construction of State aid projects.

Road Funds

The highway department, board of State engineers, will have available during 1916, approximately \$135,000 for distribution among parishes applying for State aid. The department will probably have under construction during 1916 approximately 200 miles of State aid projects to cost about \$600,000.

Bonds are being issued and special taxes voted in nearly all of the parishes.

Total expenditures for State aid roads up to December 31, 1915: State funds, \$389,467.42; parish funds, \$719,328.89; total, \$1,108,796.31, exclusive of cost of gravel furnished by parishes for gravel roads. These amounts are supplemented by labor of State convicts.

Publications

Board of State Engineers

Biennial Reports, 1872-73 to 1912-14, inclusive.

Agricultural Experiment Station

Geology and agriculture, part 5, 1899. Road making.

Gamble's compendium of the law of roads in Louisiana, with special forms for bond and tax elections.

[Approved by CHAS. F. WOOD, Secretary.]

MAINE

State Aid Legislation

Under an act passed in 1913 "the governor with the advice and consent of the council shall appoint a State highway commission consisting of three members; one to serve three years, one to serve two years and one to serve one year.

"The commission shall select, and with the approval of the governor and council appoint a chief engineer, upon terms to be fixed from time to time by the commission, subject to the approval of the governor and council."

He shall under the direction of and control of the commission have general charge of the office, the records and all construction and maintenance work, and may with the approval of the commission employ necessary clerical assistance. The engineer may with the approval of the commission employ such other engineers, supervisors, assistants and help as he may deem necessary.

The commission shall lay out, construct and maintain a system of State and State aid highways. The State highways to be constructed wholly by the State from the bond issue. The State aid highways to be constructed by the State and municipalities jointly. Both classes of highways to be maintained under the direction of the commission, the cost to be borne jointly by the State and municipalities. The charge against the municipalities for maintenance of State highways shall be \$60 per mile per annum; for State aid highways, the charge shall be one-half the actual expense but not to exceed \$30 per mile per annum.

The commission have full power in the letting of all contracts for the construction of all State and State aid highways. The commission may make contracts with towns for construction of State aid roads without advertising for bids.

Towns may make the following appropriations and apply for State aid:

Towns having a valuation of \$200,000 or less may appropriate any amount, not exceeding \$300; towns having a valuation of over \$200,000 and not over \$800,000 may appropriate any amount not exceeding \$533; towns having a valuation of over \$800,000 and not over \$1,000,000 may appropriate an amount not exceeding \$600; and towns having a valuation of over \$1,000,000 and not over \$3,000,000 may appropriate in addition to the sum of \$600 an additional sum of \$66 for each \$200,000 or fraction thereof valuation in excess of \$1,000,000; towns having a valuation of over \$3,000,000 and not over \$4,000,000 may appropriate, not exceeding \$1333, and towns having a valuation of \$4,000,000 may appropriate in addition to the sum of \$1333 an additional sum not exceeding \$133 for each additional \$1,000,000 of additional valuation.

The commission from the funds for State aid construction shall to each town which has conformed to the provisions of the act, for each dollar so appropriated, apportion the following amounts:

To each town having a valuation of \$200,000 or less, \$2 for each dollar appropriated by said town; to each town having a valuation over \$200,000 and not over \$1,000,000 \$1 for each \$1 appropriated by said town; to each town having a valuation of over \$1,000,000 and not over \$1,200,000 92 cents for each \$1 appropriated by said town; to each town having a valuation over \$1,200,000 and not over \$1,400,000, 85 cents for each \$1 appropriated by said town; to each town having a valuation over \$1,400,000 and not over \$1,600,000, 80 cents for each \$1 appropriated by said town; and to each town having a valuation over \$1,600,000, 75 cents for each \$1 so appropriated by said town. The money appropriated by towns applying for State

aid with the amount apportioned by the commission shall constitute a joint fund for the construction and improvement of the State aid highways in such towns.

After the year 1913, between the 15th day of July and the 15th day of August in each year, municipal officers shall prepare and file with the commission, suggestions for the improvement during the next calendar year of State aid highways located in each town accompanied by plans so far as practicable, setting forth the location of the highway and the nature of the improvement desired. The commission shall examine and report thereon with its recommendations to the municipal officers on or before the 20th day of February following. Such reports shall be submitted to the voters of such towns at the next regular meeting.

To provide funds for the construction of State aid highways there shall be appropriated for the year 1913 the sum of \$250,000 and annually thereafter there shall be appropriated the sum of \$300,000. To provide for the administration of the office and duties of the commission and for all expenditures, salaries and expenses incident thereto, and for the maintenance of all State and State aid highways there shall be appropriated the sum of \$50,000 annually. For the construction of the State roads the treasurer of State is authorized under the direction of the governor and council to issue from time to time serial coupon bonds, not exceeding \$2,000,000 in amount outstanding at any one time, payable at the State treasury within forty-one years from date of issue; the interest on the bond issue and retirement of bonds to be provided for from the automobile license fees. Not more than \$500,000 of bonds shall be issued in any one year.

The fund for maintenance and administration is augmented each year by the balance remaining on the 31st of December in the appropriation for State aid highways; that is, so much of the State's appropriation for this purpose as has not been apportioned to municipalities on account of State aid is automatically carried into the fund for administration and maintenance for the succeeding year. This fund is further augmented by the balance remaining in the fund created by the licensing of automobiles after providing for the payment of interest on the bonds issued and a sinking fund for the retirement of bonds.

Chapter 272, laws of 1915, placed the maintenance of all the principal thoroughfares in the State, both improved and unimproved, under the direction of the State highway commission, the work to be done at the joint expense of the State and the towns.

Local Road Legislation

Jurisdiction over roads vests in the boards of county commissioners in the case of county roads and all roads in unincorporated

towns; all other local roads are under the boards of selectmen of the towns.

Convict Labor Laws

Upon written application from county or municipal authorities the board of prison inspectors may direct that jail prisoners be worked on county roads.

Automobile Registration

The law provides for annual registration with the secretary of State. The schedule of fees is as follows: 20 h.p. or less, \$5; 21 to 35 h.p., \$10; over 35 h.p., \$15; motor trucks and commercial automobiles, \$10; traction engines, \$10; motor cycles, \$3; operators, including owners, \$2.

Registration revenue is paid into the State treasury and credited to a fund for the repair, maintenance and construction of State highways. (Chapter No. 162, Laws 1911.)

Highway Officials

State Highway Commission, Augusta.—Philip J. Deering, chairman; William M. Ayer, Frank A. Peabody; Paul D. Sargent, chief engineer.

Progress Report

The State aid road work done in 1915 comprised 135.79 miles of gravel roads costing \$458,091; 9.10 miles of earth roads, \$27,503; 3.27 miles of macadam roads, \$22,934; 3.09 miles of bituminous macadam roads, \$42,408; \$1.44 miles of concrete roads, \$31,064; 0.45 mile of granite block road, \$12,032; 0.57 mile of sand clay road, \$2,364; total, 153.71 miles.

There were 10.41 miles of bituminous macadam and 19.94 miles of gravel roads completed in the State highway system in 1915, contracts for which were let in 1914. Contracts for State highways let in 1915 comprised 7.69 miles of concrete roads, 4.78 miles of macadam roads, 3.77 miles of sand-clay roads and 30.08 miles of gravel roads. There were also built by force account, 2.98 miles of sand-clay roads and 11.33 miles of gravel roads.

The average cost per mile of some of the recent work has been: Concrete, \$11,800; bituminous macadam, \$12,250; macadam, \$7200; gravel, \$5000; sand clay, \$4400.

The department spent \$28,049 on roads and \$49,057 on bridges under special resolves.

During 1915, 759.83 miles of State aid highways were maintained at a cost of \$103,180, and 195.95 miles of State highways were maintained at a cost of \$66,226, a total for maintenance of \$169,406, of which the towns contributed \$46,127.

Road Funds

During 1915, the State highway commission spent \$1,467,246. For 1916, \$500,000 will be available from State aid highway bonds, \$300,000 from State aid appropriations, and \$300,000 from cities and towns, or a total of \$1,100,000 for construction. For maintenance the State has appropriated \$50,000; about \$200,000 will be available from automobile licenses, and \$300,000 from towns, making a total of \$550,000. The total sum for roads this year under the commission, is thus about \$1,650,000.

Publications

Commissioners of highways.

Annual Reports 1905 to 1915 inclusive.

Bulletin 1. Improvements of country roads, 1909.

Bulletin 2. Road administration.

Bulletin 3. Duties of selectmen and road commissioners.

[Approved by PAUL D. SARGENT, Chief Engineer.]

MARYLAND*State Aid Legislation*

The State roads commission consisting of six members appointed by the governor has direct control over the construction and maintenance of a system of main highways through all the counties in the State, the cost of such construction and maintenance to be borne entirely by the State. The commission also has authority to approve applications for State aid on roads not included in the trunk-line system, and when such applications are approved the plans and specifications are prepared by the State, the contract awarded by the counties subject to approval of the State, and the performance of the contract supervised by the State.

The cost of State aid roads is shared equally by the State and counties. The allotment of State funds to the counties is based upon road mileage. After the construction of a State aid road its maintenance devolves upon the county authorities subject to the approval of the State.

A system of trunk-line roads, built and maintained entirely at the expense of the State, was authorized by the legislature in 1908, and a State bond issue of \$5,000,000 was authorized for this purpose. An additional bond issue of \$1,000,000 was authorized by the legislature in 1910, in 1912, a bond issue of \$3,170,000 was authorized, and \$6,600,000 in 1914. The trunk-line system is selected entirely by the State roads commission and every stage of the work is completely under the control

of the commission. A chief engineer selected by the commission is the executive officer and active head of the work. The funds for State aid roads as distinguished from State roads are provided by direct appropriation. The legislature in 1912 provided that an annual State tax of 1 cent on each \$100 should be levied to provide a maintenance fund for State highways.

Local Road Legislation

Jurisdiction over county roads vests in elected boards of county commissioners who may employ competent civil engineers for the construction and maintenance of bridges and roads.

Convict Labor Laws

For the purpose of building and constructing or maintaining any road, bridges or highways under the provisions of this act (State highway act of 1910) or for the purpose of working any stone quarry operated by the State roads commission, the said commission is authorized to make request of the directors of the Maryland House of Correction for as many inmates thereof as may be necessary for said purpose, and the said directors are directed to furnish same with a sufficient number of guards for their safe-keeping of the prisoners while so employed.

The use of convicts on public roads in certain counties is also authorized by law.

Automobile Registration

The law provides for annual registration with the commissioner of motor vehicles at Baltimore. The registration fees are as follows: 10 h.p. or less, \$5; 11 to 20 h.p., \$10; 21 to 30 h.p., \$15; 31 to 40 h.p., \$20; and over 40 h.p., \$25.00; all commercial motor vehicles \$3; motor cycles \$1.80; dealers and manufacturers (motor cycles, \$10), \$24; operators, including owners (motor cycles, \$1), \$2.

One-fifth of the net registration revenue is apportioned to the city of Baltimore for use on its roads and streets and the remainder shall be expended for oiling, repair and maintenance of the modern State and county roads. Fines and forfeitures are paid into the State treasury for the same use as the registration revenues.

The commissioner of motor vehicles is authorized to expend from the receipts of his office each year not exceeding \$1000 for the erection of sign posts for the direction of and warning of danger to travelers. The said commissioner is also authorized to employ deputies equipped with motor cycles to enforce the motor vehicle and traffic laws of the State and pay for same in an amount not exceeding \$5000 per year from the receipts of his office.

No motor vehicle in excess of 90 inches width, and no traction engine in excess of 100 inches width shall be operated on highways of State; or in which the limit of load is over 800 pounds per inch in width of tire without special permit from State roads commission, if a State road, or proper local authorities of other road. No motor vehicle of which the weight of truck and load exceeds 14 tons shall be operated on any highway.

Highway Officials

Gov. P. L. Goldsborough; chairman, O. E. Weller; W. B. Miller, Andrew Ramsay, Thomas Parran, John M. Perry, J. Frank Smith; assistant to chairman, F. H. Zouck; chief engineer, Henry G. Shirley; secretary, William L. Marcy; counsel, Leon E. Greenbaum.

Progress Report

In 1915, 202 miles of new State roads were begun, and 187 miles completed, 504 miles were oiled and 1049 miles were maintained. About 1000 miles of the State trunk roads were completed at the end of the year. On State aid work, 73 miles of new road were started and 55 miles finished. The 275 miles of finished road of both classes cost \$3,242,375.

Road Funds

It is expected that the legislature will appropriate \$2,500,000 for State road work in 1916. The State-aid funds furnished jointly by the State and the counties are expected to yield at least \$500,000, and the counties will probably spend about \$2,000,000 on their roads.

Publications

State Geological Survey.

Report on the highways of Maryland, 1899.

Report on the highways of Maryland with especial reference to the operations of the highway division during 1900 and 1901 (1902).

Report on the highways of Maryland with especial reference to the operations of the highway division during 1902 and 1903 (1903).

Report on the highways of Maryland for the period from January 1, 1904, to May 1, 1905 (1906).

Report on State highway construction for the period from May 1, 1905, to January 1, 1906 (1906).

Report on State highway construction for the period from January 1, 1906, to January 1, 1908, (1908).

Report on State highway construction for the period from January 1, 1908 to January 1, 1910 (1910).

First, second, third and fourth annual reports of the State Roads Commission for 1908, 1909, 1910, and 1911.

Progress report for 1912 and 1913.

Preliminary report for 1912-15.

[Approved by H. G. SHIRLEY, Chief Engineer.]

MASSACHUSETTS*State Aid Legislation*

A State highway commission consisting of three members appointed by the governor for a term of three years, one term expiring each year, has control over the construction and maintenance of roads, partially or wholly paid for by the State.

The duties of the commission relate to roads and automobiles. Its duties so far as they relate to roads are: (a) The collection of statistics as to road materials and road conditions in the State, the making of maps, the giving of advice to local road authorities, etc.; (b) the laying out and construction of State highways, the improvement of certain town roads, and the supervision of maintenance of State highways.

The State highways are such as are designated by the commission upon petition of the city government, the board of selectmen, or the county commissioners. As soon as a highway has been thus designated, it passes under complete jurisdiction of the State highway commission, which has control not only of construction and maintenance but also of the location of water and gas mains, poles or other structures, the planting or cutting down of trees on the right of way, etc.

The cost of constructing State highways is borne as follows: 75 per cent by the State and 25 per cent by the county in which the highway is located, the State paying the entire cost on the first instance and collecting as a refund the 25 per cent from the county.

In order to aid the small towns, 15 per cent of the amount appropriated annually for State highway construction may be expended as follows: 5 per cent in towns of less than \$1,000,000 valuation, upon petition, the town making no contribution; 5 per cent in towns of less than \$1,000,000 valuation, the towns contributing an equal amount; and 5 per cent in towns of more than \$1,000,000 valuation, the towns contributing an equal amount, which amount must be in excess of its average annual appropriation for roads for the last five years.

This has been amended by the acts of 1913, chapter 774, which provides that when any road has been constructed or improved, in whole or in part, with money furnished by the commonwealth, and is not laid out as a State highway, the city, town, or county shall at all times keep it in good repair and condition. The commission shall from time to time notify the authorities in charge of the road whenever it is not so kept in condition, and shall specify what repairs or improvements are necessary, and said authorities shall forthwith proceed to make the specified

repairs and improvements. If not made within sixty days (unless further time is allowed) the commission may do the specified work and pay for the same from any money available for the maintenance of State highways or from the part of the motor vehicle fees' fund available for work on through routes in the towns (20 per cent of the net). The amount of such expenditures shall be collected back in the manner in which the expense of repairs on State highways is collected (see above). The money collected to be available for use for the same purposes for which the money so expended was available, or for the repair and maintenance of State highways: but in towns of under \$1,000,000 valuation not more than \$50 a mile a year; in towns with a valuation of over \$1,000,000 and under \$2,000,000 not more than \$100 a mile a year, and in towns with over \$2,000,000 valuation not more than \$200 a mile a year shall be collected in any one year; but any balance due may be collected in succeeding years, the maximum collection in any one year being as above stated. The commission may upon petition exempt any town from the whole or any part of such payment if in its judgment said payment would prove to be an undue burden.

The State highway commission maintains the State highways at the expense of the State in the first instance, and the counties are required to repay to the State 25 per cent of the amount expended by the State for maintenance. This has been amended by the acts of 1913, chapter 773, so that not exceeding \$50 a mile a year is collected back from towns of under \$1,000,000 valuation; not exceeding \$100 a mile a year from towns whose valuation is from \$1,000,000 to \$2,000,000; not exceeding \$200 a mile a year from towns whose valuation is from \$2,000,000 to \$5,000,000 and in cities and towns of a valuation of over \$5,000,000, one-half said expenditures, not exceeding \$2000 a mile in the aggregate, and not exceeding \$500 a mile in any one year, shall be made a part of the State tax and collected, and any balance due may be made a part of the State tax for the succeeding three years. The amount collected shall be credited to the appropriation for State highways, to be used again by the commission.

The State road revenues are derived from State bond issues, usually authorized for five years, one-fifth of the amount authorized to be issued each year during the five-year period. The present bond issue is at the rate of \$1,000,000 per annum. Of the automobile fees and fines, after deducting the expense of administering the automobile department, 80 per cent is applied to the maintenance of State highways, and 20 per cent is spent on through routes in the towns. The net fees, fines, etc., now amount to from \$1,100,000 to \$1,200,000 per annum. In addition,

the legislature makes direct appropriations from time to time to meet special expenses and additional maintenance cost. The towns in 1915 appropriated over \$300,000 of their own money to go with the \$150,000 State aid money and the \$200,000 motor vehicle fee money appropriated by the Commission for road improvement in the towns. Work was done in 180 towns with these two funds in addition to the building of State highways.

As indicating the manner in which the law is carried out in relation to road construction by the State highway commission, it may be stated that contracts are awarded by the commission to the city or town in which the highway is to be laid out, if prices are satisfactory to the commission and if the contract is acceptable to the local authorities. The work is then done by the local authorities under the direction of the commission and its engineers. The contracts for State highway construction are usually based on given unit prices for each item of work, while the small town contracts are on the lump-sum basis. If the local authorities do not take the contract, bids are advertised for and awarded in the usual way.

The organization of the commission is as follows: A central office at Boston with three commissioners, a secretary, the various assistants in the highway department, the motor-vehicle department, and a chief engineer. The State is divided into four divisions each in charge of a division engineer, who has the necessary assistants and resident engineers, who are employed directly on the work. State issues bonds for road construction.

Local Road Legislation

The local roads are under the boards of selectmen of the towns or under a superintendent of streets, or under district road surveyors, as the town, from time to time determine. A county commissioner may, upon petition, lay out new roads or make specific improvements, and may direct towns and cities to make such improvements.

Convict Labor Law

By Chapter 633 of the acts of 1913 there was a provision for using prisoners in improving waste and unused land. In 1914 this act was amended so that the county commissioners could make arrangements with the officials of any city or town or with the highway commission to work prisoners on any highway, the prisoners to be in the custody of the sheriff of the county. When land that is not the property of the county, or is a highway, is so improved, the owners thereof or those having in charge the

highway shall pay to the county such sums as may be agreed upon between the county commissioners, sheriff, and the other parties in interest, for the labor of any prisoners employed thereon.

There were 1½ miles of macadam road built in 1915 under the provisions of this act, solely by the labor of prisoners, and undoubtedly more will be built in the near future.

Civil Service Laws Applicable to Road Officials

In all work of any branch of the service of the commonwealth, or of any city or town therein, citizens of the commonwealth shall be given preference. The civil service commission shall not place upon its list any person not a citizen of the United States. If an appointing officer, by reason of the non-existence of an eligible list, shall appoint under provisional authority from the civil service commission a person not a citizen of the United States, he shall discharge the person so appointed and appoint from the eligible list, whenever the civil service commission shall have established a list of the proper class. When the attention of the civil service is called, by a complaint on the part of the citizens, to the employment of a non-citizen when there is an eligible list, the commission shall take steps to enforce the dismissal of such non-citizen and make an appointment in his stead from the suitable eligible list. A penalty is provided for appointing officers continuing the employment of a non-citizen for a period of ten days after having due notice of such unlawful employment.

Automobile Registration

The law provides for annual registration with the State highway commission. The registration fees are as follows: Less than 20 h.p., \$5; 20 to 29 h.p., \$10; 30 to 39 h.p., \$15; 40 to 49 h.p., \$20; 50 h.p. and over, \$25; motor cycles, \$2; all commercial automobiles and trucks, \$5 for each one of one ton capacity and \$3 additional for each additional ton or fraction thereof; dealers and manufacturers, \$25; and \$5 for each additional car over five demonstrated on the roads; dealers and manufacturers motor cycles only, \$10; operators, including owners, \$2. Non-residents are exempt to such an extent as the State of their residence grants exemption to the residents of the State of Massachusetts. The term "non-residents" is defined to be those who have no regular place of abode or business in the State of Massachusetts for a period of more than 30 days in the calendar year.

The net registration revenue shall be expended under the direction of the State highway commission for maintenance of State highways, provided that an amount not exceeding twenty per

cent of such reveuene may be expended by the Commission for the repair, improvement and construction of local roads used as through routes. All fines and forfeitures are credited to the same fund as registration receipts.

Highway Officials

State Highway Commission, Boston.—William D. Sohler, chairman; Frank D. Kemp, James W. Synan, Frank I. Bieler, secretary; Arthur W. Dean, chief engineer.

Progress Report

About 62 miles of State highway were laid during 1915 and work completed on over 66 miles laid out in 1914-1915. The commissioners have constructed in all under the "small town" act over 482 miles, and with money available from the motor vehicle fees for use in towns nearly 230 miles of road have been constructed and improved, and from special appropriations, over 52 miles have been constructed.

The commission has been doing work in 340 cities and towns out of 353 in the State, under the "small town" act, State highway, motor vehicle fees, etc.

Of State highways constructed in 1915, 30.5 miles were bituminous macadam, 0.65 mile waterbound macadam which will be covered with bituminous binder, 1.90 miles gravel, 3.75 miles asphaltic oil, 0.14 mile macadam covered with heavy asphaltic oil, 5.35 miles of concrete, 5.61 miles of bituminous gravel, 5.84 miles of waterbound macadam with light oil, 5.59 miles of gravel with light oil, 0.75 mile of graded road to be surfaced later.

There were 182 miles of road completed in 1915 from State highway, State aid, and special funds. Of this 23.26 miles were waterbound macadam, 58.60 miles gravel, 4.13 miles sand bound with oil and asphalt; 38.62 miles macadam with bituminous binder incorporated in the top course; 19.62 miles waterbound macadam with an oil surface applied; 7.65 miles gravel with the top surface bound with bituminous binder; 5.34 miles cement concrete; 16.61 miles gravel with an oil surface applied; 1.30 miles Warrenite; 0.09 mile granite block on a concrete foundation, and 6.70 miles dirt roads surfaced with the best available material.

The commission has continued to fill in the gaps on the through roads as rapidly as possible, and almost all cities and towns have cooperated so that a number of the main through lines will soon be completed.

During 1915 bituminous materials were used on practically all of the 1100 miles of State highway. Over 65 miles of the older

roads were resurfaced and 64 miles of the older roads were also widened from 15 to 18 ft. with 21 ft. on curves. Over 4,000,000 gals. of bituminous materials were used.

Total expenditures in 1915 for road purposes were as follows: expenditures by the towns, \$3,318,742; expenditures by the cities, \$6,645,985; a total by both cities and towns of \$9,964,727. The mileage and classification of improved roads in the State at the close of 1915 were as follows: gravel roads, 7808 miles; plain macadam roads, 2040 miles; bituminous macadam roads, 495 miles; macadam with oil or tar coat, 1340 miles; pavement, 455 miles; dirt roads, 10,893 miles; a total of 23,031 miles.

Road Funds

The average yearly appropriation of late by the cities and towns in Massachusetts for highways and bridges was \$9,921,855. The cities and towns have also an excise and franchise tax available from the street railway companies, amounting to \$1,633,919 in 1914, making a total of \$11,555,774. These taxes were collected for 1914 and apply approximately to 1915 and 1916. These expenditures were those made by the cities and towns but did not include the expenditures of the State for State highways, State aid roads, etc.

The State highway commission expended in 1915 for new construction, including State highways and "small town" work and the work done with money obtainable from the motor vehicle fees, \$1,087,499.89. It spent under a special act \$154,126 on several routes, making \$1,241,625. It had available for construction under special acts of the legislature \$239,504.45, making a total of \$1,481,130.

It also expended for the maintenance of highways, bridges, etc., \$1,123,998.34; for general office expenses, salaries of the commissioners, etc., \$76,299.47. The automobile department, which has to investigate automobile accidents, care for the registration of cars and the issuing of number plates, etc., expended \$130,657.82. The total expenditure of the department was \$2,782,877.07. The total expenditures for highways by the cities and towns and the State amounted to about \$14,237,202.

In 1916 the State highway department has available from the loan fund for State highway work and "small town" work \$1,000,000; for work in the towns under the Motor Vehicle Fees act, about \$200,000, and for the maintenance of bridges \$16,500; for the repair and maintenance of State highways from the tax levy, probably \$450,000, and from the motor vehicle fee fund about \$900,000. There is also available from certain special acts

of the legislature requiring the construction of particular roads, something over \$90,000; under a special act for improving 17 different routes in 38 towns and one city, \$500,000 or more is available this year for the improvement of 163 miles of road; also \$28,000 for tree work and the maintenance of road machinery; making a total to be expended by this department in 1916 of \$3,184,000. To this should be added from \$300,000 to \$400,000 that will undoubtedly be appropriated by the towns and cities to be used with the State funds.

There are a large number of propositions relating to particular roads now pending before the legislature, some of which may become a law and additional appropriations may be made for the purpose of constructing particular roads.

Publications

State Highway Commission

Annual report 1892. Economics of Massachusetts roads. Table showing mileage of pavements. Road machinery and cost of same.

Article on road materials of Massachusetts regarding construction of highways. Statistics showing area, roads, valuations, appropriations, and population with percentages regarding tax and valuation.

Annual report, 1893. In House documents 1894.

Annual reports, 1894 to 1904. In public documents, vol. 12.

Annual report, 1894. Analysis of costs of crushed stone.

Annual report, 1896. Laboratory experiments on road building stones.

Annual report, 1896-1898. Tables showing quantities of work done on each road since 1894 and total cost of same.

Annual report, 1899. Instructions of highway commission to engineers; approved March 30, 1899. Road materials and their physical properties.

Annual reports, first to twenty-first, 1893 to 1914-1915.

Annual report, 1909. Traffic census.

Annual report, 1912. Traffic census on State highways, etc.

Report, 1912. Knowledge of traffic a prerequisite to selection of pavement.

Annual report, 1913. French and English costs, road building and maintenance.

Annual reports 1906 to 1913. Automobile regulations, etc.

Annual Reports 1907 to 1913. Telephone investigations, rates, etc.

Annual Report, 1915. Traffic census: Character of roads for horse drawn and motor vehicles.

State Board of Agriculture

Annual report 1900. Better roads for Massachusetts.

Prize essays on roads and road making. 1870.

State Board of Education

Annual report 1902. Comments on cost of conveyance of children to and from schools.

State Library

Extracts from public hearings given during 1892 in various counties of State regarding width of wagon tires.

Boston Public Library

Preliminary report of the highway commission.

State Legislature

Senate document 164, 1875. Report of Board of Agriculture on most suitable width of rims of wheels of loaded wagons.

House document 253, 1880. Report on subject of "broad rimmed wheels."

Highway Association Journal

Volume 1, nos. 2 to 4.

Volume 2, nos. 1 to 4.

Volume 3, nos. 1, 3 and 4.

Volume 4, nos. 1 and 2.

November 1907-08.

June 1910-11.

Proceedings.

[Approved by COL. WM. D. SENTER, Chairman,
Massachusetts Highway Commission.]

MICHIGAN

State Aid Legislation

The law provides that in 1913 and every four years thereafter a State highway commissioner shall be nominated and elected by the people at the same time and in the same manner as the justices of the supreme court. He is required to be a citizen of the State and may appoint a deputy, who shall be a civil engineer skilled in road building, and such other assistants as may be necessary. His duties are to give instruction in road and bridge construction and maintenance, to collect statistics, and distribute State-reward funds or any funds given to the State for such purposes by the United States government or by individuals. He is required to give expert advice to the local authorities and is required to make a map of every township in the State showing the roads and their condition and the location, kind, and quantity of road materials, etc. His decision is final as to whether a road merits State reward, and he may withhold any portion of the reward until the road has been thoroughly tested.

Whenever any township board or board of county commissioner or good roads district commissioners have made arrangements to improve a mile or more of public road by constructing a sand-clay, gravel, stone-gravel, gravel-stone, macadam, concrete or brick road and ask for an allotment of State reward, and file with the State highway department a profile of the highway to be improved, and make application for plans and general specifications, the State highway commissioner shall furnish the plans and specifications and allot the funds from the State treasury as the State reward if, after completion, he finds the road to be up to the required standard. Each surveyed township is entitled to receive State reward on no less than 1 or more than 4 miles of road in any one fiscal year. The reward is allotted as follows:

a. Each mile of well graded road, with grade not exceeding 6 per cent, except where found impracticable and a steeper grade is recommended after examination by the State highway commissioner, width not less than 20 feet between side ditches, properly drained, with travel track not less than 9 feet, made of a mixture of sand and clay, shall merit if approved by the State highway commissioner, a reward of \$250 per mile, and pro rata for extra miles, with an extra \$25 for each additional foot in width of metaled surface in excess of 9 feet up to and including 16 feet.

b. Every mile of well graded road having not to exceed 6 per cent grade, except where found impracticable and a steeper grade is recommended after examination by the State highway commissioner, width not less than 20 feet between ditches, well drained, travel track not less than 9 feet, surface not less than 8 inches compacted gravel applied in not less than two courses, each rolled separately, shall merit, if approved by the State highway commissioner, a reward of \$500 per mile, with an extra \$50 per mile for each additional foot in width of metaled surface in excess of 9 feet up to and including 16 feet.

c. Every mile of well graded road having not to exceed 6 per cent grade, with not less than 20 feet between ditches, well drained, travel track not less than 9 feet and having a foundation not less than 4 inches of crushed stone, slag or other material compacted, and top course of layer of gravel not less than 3 inches, shall merit, if approved by the State highway commissioner, a reward of \$750 per mile, with an extra \$75 for each additional foot in width of metaled surface in excess of 9 feet up to and including 16 feet.

d. Every mile conforming to the above conditions as to grade, width, drainage, etc., and having a bottom course of gravel, slag or other material not less than 4 inches thick after rolling and a top course of crushed stone not less than 3 inches thick after rolling shall merit, if approved, a reward of \$750 per mile, with an extra \$75 per mile for each additional foot in width of metaled surface in excess of 9 feet up to and including 16 feet.

e. Every mile conforming to the foregoing as to width, grade, drainage, etc., and having a surface of well compacted macadam not less than 6 inches thick laid in not less than two courses, each properly bonded, shall merit, if approved, a reward of \$1000 per mile, with an extra \$100 per mile for each additional foot in width of metaled surface in excess of 9 feet up to and including 16 feet.

f. Every mile conforming to the foregoing as to grade, drainage, etc., and having properly laid concrete not less than 6 inches in thickness with or without a paving brick surface, shall merit, if approved, a reward of \$900 per mile, with an

extra \$100 per mile for each additional foot in width of metaled surface in excess of 8 feet up to and including 16 feet.

g. Every mile conforming to the foregoing as to grade, drainage, etc., and consisting of a paving brick surface laid on gravel, sand, broken stone or slag, the quality of brick, manner of laying and kind of inspection employed to be made to comply with the specifications made by, or approved by the State highway commissioner, shall merit, if approved, a reward of \$900 per mile, with an extra \$100 per mile for each additional foot in width of metaled surface in excess of 8 feet up to and including 16 feet.

Firm earth, gravel or macadam shoulders must be placed on each side of the concrete and brick 8-foot metal track.

Two or more townships may act jointly in the improvement of boundary line roads.

The State highway department is required to design, construct and maintain all bridges of 30 feet clear span and over on State trunk line roads, provided the county, township or good roads district agrees to construct at least 3 miles of road including the bridge site. The State highway department is required to design, construct and maintain all bridges of more than 30 feet clear span on State reward roads, if the county, township or good roads district spends in building the road or roads including the bridge site an amount, not including the State reward, equal to the estimated cost of the bridge plus the State reward merited.

The 1913 legislature of Michigan passed what is known as the trunk line highway act, which delineates certain highways leading from town to town in the State, totalling about 3000 miles, upon which townships and counties will be entitled to double the State rewards mentioned above, when they build roads according to specifications drawn by the State highway department. The fixing of the location of these routes between towns, the preliminary surveys and the drafting of specifications are in the hands of the State highway department, while the construction of the roads is in the hands of the townships and counties through which they pass.

The 1915 legislature authorized the local township officials or, where the county road system had been adopted, the county highway officials and the State highway commissioner, to lay out additional trunk line mileage up to 3 miles per surveyed township.

Local Road Laws

The commissioner of highways of each township has charge of town roads and the board of county road commissioners of each county adopting that system has charge of county roads.

The Assessment District Law provides that a petition signed by 51 per cent of the abutting land owners may be presented to the board of county road commissioners where the county road system is in force or to the State highway commissioner elsewhere for the improvement of not less than 2 miles of road. Not less than 25 per cent nor more than 75 per cent of the cost is borne by the local assessment district and the remainder by the townships benefited or the county where the county road system is in force.

Road Bond Legislation

The township board of any organized township, upon petition of at least twenty-five freeholders thereof, may submit to an election the proposition of issuing bonds of the township in an amount not exceeding 5 per cent of the assessed valuation thereof, for improving the roads therein under the commissioner of highways, subject to direction of the township board a majority of the legal voters voting is necessary to authorize the bond issue. These bonds shall bear not to exceed 5 per cent interest and shall run not to exceed twenty-five years, and a tax shall be levied annually to meet the interest and principal as fast as they become due.

Counties that have adopted the county road system may issue bonds to pay for such improvements as the commissioners of highways decide to make, in an amount not exceeding 3 per cent of the valuation of property assessable for this purpose. Before issuing these bonds, the county board of supervisors must order an election to decide on the issue. A majority of votes cast is required to authorize the bond issue. Bonds shall not be sold for less than par and shall run for not exceeding twenty years. The rate of interest and method of payment are not specified.

Convict Labor Law

County road officials may direct the employment of county prisoners confined for petty offenses, upon the highways of the county.

The wardens of the State penitentiaries may, upon proper application from highway officials, put State prisoners to work in the same manner as county prisoners. State convicts may also be used in surface quarries and stone yards in preparing material to be used on the public highways.

Automobile Registration

All automobiles must be registered annually with the secretary of State. The fees for steam and gasoline vehicles are 25 cents per horse power plus 25 cents per 100 lbs. weight. The fees for

electric vehicles are \$1 per horse power plus 25 cents per 100 lbs. weight. Half the money is returned to the counties for road purposes and half is paid into the State reward fund.

Highway Officials

Frank F. Rogers, *State highway commissioner*, Lansing; Leroy C. Smith, *deputy highway commissioner*.

Progress Report

The total length of road in the State is estimated to be 74,191 miles, of which it is estimated that approximately 8000 miles are hard surfaced. No roads have been built entirely at the expense of the State, but there are 11 miles under construction at the expense of the State by special appropriations, the total length of roads constructed partly at the expense of the local subdivision, is 3200 miles and it is estimated that about 1000 miles are under construction at joint expense of State and local subdivisions. No roads are maintained entirely at the expense of the State but the entire 3200 miles of State roads are maintained by townships and counties under the supervision of State highway department. During the fiscal year ending July 1, 1915, 760 miles of road were accepted as State rewarded roads. The total expenditure from State funds during this fiscal year was as follows: ordinary State reward, \$583,895, and trunk line reward, \$199,671. Under the trunk line system the law provided that all bridges over 30-foot span, located on the trunk line were to be built by the State, so during this fiscal year, 20 bridges made up of concrete arches, through girders, reinforced I-beam bridges were built. The total expenditure of these bridges amounted to approximately \$120,000.

Road Funds

Owing to the old automobile law being declared unconstitutional by the supreme court, the State highway department had no State reward money for the year ending June 30, 1915. The legislature accordingly made a deficiency appropriation for State reward of \$600,000, and an appropriation of \$625,000 for the year ending June 30, 1916, and \$350,000 for trunk line reward for the same year. During the year ending June 30, 1915, the State highway department paid out \$783,566 in rewards on roads. About \$6,000,000 will be raised for road purposes in 1916 by taxation and bonds by the townships and counties.

*Publications***State Highway Department**

Biennial reports 1905-06 to 1913-14.

Bulletin 1. Care of earth roads, 1910. F. F. Rogers (out of print).

Bulletin 2. Gravel roads, 1911. F. F. Rogers (out of print).

Bulletin 3. The county road system, 1911. F. F. Rogers (out of print).

Bulletin 4. Macadam roads, 1912. F. F. Rogers (out of print).

Circular discussing the county road system, 1914. F. F. Rogers.

Supplementary annual report, 1913. F. F. Rogers.

Concrete steel bridge specifications, 1915.

[Approved by FRANK F. ROGERS, State Highway Commissioner.]

MINNESOTA*State Aid Legislation*

The State highway commission consists of three members appointed by the governor and holding office for three years and serving without compensation, one new commissioner to be appointed each year. The commission holds meetings not less than once in each month and appoints a secretary who shall be a civil engineer and practical road builder and be known as the State engineer, and holds office subject to the pleasure of the commission. They may also employ other assistants and fix their compensation. The commission shall make report to the governor annually.

The State engineer is required to give advice under the rules of the commission and to perform such other engineering services for other State departments as the governor may require. He shall make all necessary surveys, establish grades, prepare plans and specifications, and have supervision of all work on State roads. He shall make an annual inspection of all bridges exceeding 30 feet in length, shall make report on their condition with recommendations to the State highway commission and county boards. The commission is authorized to investigate the location of road materials, investigate methods of construction, systems of road administration, hold public meetings, and apportion State aid.

A State road fund is created by an annual tax levy of 1 mill on each dollar of valuation, together with all money accruing from investments in the internal improvement land fund, 5 per cent from the sale of U. S. land and proceeds from milk and cream testing licenses. The State highway commission allots this fund to the various counties, but no county shall receive in one year more than 3 per cent nor less than 1 per cent. Twenty per cent of the allotment shall be used only for maintenance of State

roads and bridges. In determining the percentage accruing to each county the commission shall take into consideration the area, the amount of money expended in road construction, the difficulty and expense of such construction, and the extraordinary expense connected with the development of new territory.

Any county board may with the consent of the highway commission designate any established road in the county as a State road, and, if the cost does not exceed \$500, cause surveys to be made when necessary by a State assistant engineer and then proceed with the construction. If the cost is over \$500 the county board shall cause survey and plans and specifications to be made by the assistant State engineer and submit the same to the State highway commission for approval. When such approval has been obtained the county board proceeds to do the work under the supervision of the assistant State engineer, who acts under instructions of the State engineer. After completion, if the State highway commission approves the work, the State engineer certifies to the same and a warrant is issued by the State auditor for a share as provided by the law of the amount expended, but in no case shall the warrant exceed the amount allotted to such county. The assistant engineers throughout the State are appointed by the State highway commission and act under the instructions of the State engineer. The appropriation for State highway department is \$100,000 per annum.

Local Road Legislation

Jurisdiction over local roads lies with the county and township boards. The counties are required to construct and maintain State roads and must construct county roads. To finance this work the county board is authorized to levy not to exceed 3 mills each year and receive State aid in proportion to the valuation of the county. The county may purchase machinery and do its work by contract or day labor. The counties generally have a superintendent in charge of the work for the county board. County roads are laid out by petition of 24 or more voting freeholders and a road which has been traveled for six or more years also becomes a county road by adverse possession. Towns are required to construct township roads and to maintain county and township roads. Each town constitutes a road district and there is one overseer with necessary assistants to supervise the work under the direction of the town board. The electors may vote a tax on the town not exceeding 15 mills, and subsequently the town board may in case of emergency, levy an additional 5 mills, the proceeds of which constitutes the town road and bridge fund. This fund is used for construction and improvement of town

roads, for which contracts are entered into, or the work is done by day labor, as the town board elects. There is also a compulsory tax of 1 mill levied by the county auditor, and paid to the town, which forms the dragging fund, used only for dragging the township and county roads and for purchasing drags.

Road Bond Legislation

On petition of 50 or more voters who are freeholders of the county, the county commissioners may submit to vote the proposition of issuing county bonds for road purposes. If a majority of those voting are in favor of the proposition, the county board shall issue bonds of the county in such amount as will not, with existing indebtedness, make the total indebtedness of the county exceed 15 per cent of the assessed valuation of taxable real property therein. These bonds shall bear not to exceed 6 per cent interest, shall have coupons attached, and shall be paid in equal installments—the first to become due and payable not less than five years after the date thereof, and the last not more than twenty years after such date.

The town board, to make extraordinary improvements that will cost more than the town is otherwise authorized to appropriate, on petition of 15 or more voters of the town owning real estate therein, may submit the question of the improvement to the next annual town meeting, or, if so requested, may call a special town meeting to vote on the question, and a 60 per cent majority vote shall authorize the improvement. The town board may then issue bonds of the town to raise the necessary funds. The amount of these bonds, with the existing indebtedness of the town, shall not exceed 5 per cent of the assessed valuation thereof. Such bonds shall bear not to exceed 6 per cent interest, shall have coupons attached, and shall be due in ten equal installments, the first of which shall become due and payable not more than eighteen months after date, and one each consecutive year thereafter. A tax shall be levied to pay the interest and principal of such bonds as they become due.

Convict Labor Law

No legislation providing for convict labor upon highways. They may be used for crushing stone for highway purposes on the prison grounds.

Automobile Registration

The law provided for triennial registration with the secretary of State. Registration fees are as follows: All motor vehicles,

\$1.50; dealers and manufacturers, one machine in each class, \$10; chauffeur's license, \$3.

The registration revenue is not applied to roads, but is paid to the State treasury to the credit of the general fund.

Highway Officials

State Highway Commission, St. Paul.—C. M. Babcock, chairman; Fred B. Lynch, Clarence I. McNair. George W. Cooley, State engineer and secretary of commission; John H. Mullen, chief road deputy; Carl D. Nagel, chief Bridge deputy; S. C. Notestein, chief clerk.

MISSISSIPPI

State Aid Legislation

Mississippi has no State highway department, and the control of the roads, ferries and bridges of the State is vested in the county boards of supervisors by the constitution.

Local Road Legislation

Each county is divided into five districts and a supervisor is elected in each. The five supervisors constitute the board of supervisors of the county, and have full authority over roads. In most counties, the supervisors appoint three road commissioners for each district, but in a few counties a road overseer is appointed for each district. Road taxes are worked out. Special bridge and road districts can be created by election but the taxes are levied and collected by the county boards.

Road Bond Legislation

For the purpose of road and bridge improvement, the county board of supervisors may issue bonds of the county to an amount not exceeding, including all of its bonded indebtedness, 5 per cent of the assessed valuation of all taxable property in the county. These bonds shall run not exceeding forty years, shall bear interest at the rate of 6 per cent, and shall be redeemed by a sinking fund to be provided for that purpose by annual taxation.

The board of supervisors of any county is authorized to issue bonds in an amount not to exceed in the aggregate, with outstanding bonded indebtedness, 5 per cent of the assessed valuation of the county, to construct and extend the public highways of the county to connect with the improved highways of adjoining counties, so as to form a continuous system of improved inter-

county highways. Such bonds shall bear not to exceed 6 per cent interest and mature not later than 40 years from date of issue.

Supervisor districts may issue bonds for road purposes on petition to the county board of supervisors signed by 20 per cent of the qualified electors of the district. A favorable vote by a majority of those voting at an election to be called for that purpose is necessary to authorize the issue. These bonds shall run not exceeding twenty-five years, shall bear not exceeding 6 per cent interest, shall be exempt from taxation, and shall be sold for not less than par. A tax shall be levied annually to pay the interest and create a sinking fund for the discharge of such bonds at maturity.

Board of supervisors may require adjoining road districts which have constructed, or are constructing, improved roads to connect such improved roads, and apportion the cost thereof to the various districts. Said boards may, if necessary, authorize such districts to issue additional bonds to the amount required to make such connections. If 25 per cent of the electors of any such district, or districts, shall petition against such bond issue, then bonds shall not be issued unless at an election held for that purpose the majority of electors of such district, or districts, respectively, shall vote in favor of same.

When the sinking fund of any road district shall accumulate to an appreciable amount before the time for redemption of the bonds for which it is created, the road commissioners of such district may loan such accumulation at not less than 6 per cent interest on first-mortgage real estate security, on the basis of one-half of its assessed valuation.

Convict Labor Law

There is no general convict labor law in reference to highways. Most convicts are employed upon state farms. The superintendent of the penitentiary is authorized to improve and maintain roads from each convict farm in the State for a distance of 5 miles out from said farms.

In four counties, convicts between the ages of eighteen and and fifty sentenced to the farms may be required to work fifteen days on the roads.

Automobile Registration

Annual registration of motor vehicles is required with the payment of the following fees: Electric motor vehicles \$4.80, each commercial vehicle of 4400 pounds capacity or less \$8.40,

each commercial vehicle of more than 4400 pounds capacity \$16.80, motor cycles \$2.40, any other motor vehicle 36 cents per horse power. Fees are collected by the regular tax collector, the county board of supervisors being required to furnish him with supply of licenses. Three per cent of the proceeds are paid to the collector for making collections and the balance goes into the road and bridge privilege tax fund of the county in which collected. Non-residents are exempt for 60 days.

Progress Report

Bond issues totalling \$485,000 have been reported during the past year, making a grand total of about \$6,000,000 road and bridge bonds which have been voted during the past five years. Of a total of 80 counties only 9 still retain the old overseer system. It is estimated that the State had on January 1, 1916, about 2000 miles of roads surfaced with sand-clay, gravel and broken stone.

Publications

Mississippi Agricultural Experiment Station

Bulletin 67, 1901. Good dirt roads for Mississippi.

Department of Agriculture and Commerce

Bulletin, vol. 2, no. 3. Road construction and maintenance.

[Furnished by U. S. Office of Public Roads and Rural Engineering.]

MISSOURI

State Aid Legislation

The State highway commissioner is appointed by the governor for a term of four years. The highway commissioner also appoints a deputy engineer. The duties of the State highway commissioner are to devise plans and estimates for road and bridge construction and hold public meetings, to give assistance and advice to local road officials, to issue bulletins, etc. He has authority over road work and over the distribution of State aid apportioned to the counties, but his work is also investigative, advisory and educational.

Local Road Laws

Missouri has two systems of local road administration. In ninety-two counties the county court, consisting of a chairman, elected for a term of four years, and two associates, elected for two years has control, and appoints a county engineer annually except in counties which have suspended the act relating to county

engineers; divides the county into districts and appoints overseers who report to county engineer.

In 22 counties under township organization the roads in each township are under the control of a township board of three members, elected every two years, who divide the township into road districts and appoint overseers.

Road Bond Laws

When petitioned by 100 tax-paying citizens of any county, the county court thereof may submit to a vote the question of issuing bonds for road and bridge purposes, and a two-thirds majority vote of those voting is required to authorize the bond issue. Such bonds shall be coupon bonds and issued in such amount as will not, with the existing indebtedness of the county, exceed the constitutional limitation of 5 per cent of the assessed valuation of the taxable property therein; they shall bear not to exceed 5 per cent interest, shall be exempt from taxation, and shall mature and be payable within 20 years upon the call of the county court. The principal, sinking fund and interest of these bonds shall be paid by a tax levied for this purpose.

Special road districts may be organized and the board of commissioners thereof may call an election to determine whether bonds shall be issued for road purposes. A two-thirds majority of those voting shall be necessary to authorize the issuance of these bonds, which, if issued, shall be in an amount, including existing district indebtedness, not to exceed 5 per cent of the assessed valuation of the district. The bonds shall bear not exceeding 6 per cent interest, shall become due in not exceeding fifteen annual installments, the first of which shall become due not later than two years after the date of the bonds. The bonds shall be sold to the best advantage by the board of commissioners.

Convict Labor Laws

The warden and inspectors of the penitentiary may, in their discretion enter into contracts for the employment of not to exceed 300 convicts of the state penitentiary upon public roads and highways of the State at such times and places and upon such terms as the warden and inspectors deem proper.

Automobile Registration

The law provides for annual registration with the secretary of State. The schedule of fees is as follows: Less than 12 h.p., \$2; 12 to 23 h.p., \$3; 24 to 35 h.p., \$5; 36 to 47 h.p., \$7; 48 to 59 h.p., \$8; 60 to 71 h.p., \$10; 72 h.p. and over, \$12; dealers and manufacturers, \$16; chauffeur's license, \$1.50.

The registration revenue is paid into the State treasury to the credit of the State good roads fund, but specific appropriation by the legislature is necessary before expenditures are made.

Road Funds

In addition to the automobile fund, which yielded \$190,000 in 1915, all returns from corporation fees are paid into the general road fund.

Highway Officials

Highway Department.—Frank W. Buffum, State highway commissioner; E. W. Sheets, deputy commissioner; H. B. Bode, inspector. Offices, Jefferson City, Mo.

[Approved by FRANK W. BUFFUM, State Highway Commissioner.]

MONTANA

State Aid Legislation

Under an act of the legislature passed in 1913, the governor is required to appoint a State highway commission of three members consisting of the professor of civil engineering of the Montana State College of Agriculture and Mechanic Arts, ex-officio; the State engineer, ex-officio; a civil engineer who is a trained and experienced road builder, who is required to devote his entire time to the work. The commission is required to meet not less than once a month. The duty of the commission is to give advice, assistance and supervision in regard to road construction and maintenance, throughout the State.

The board of county commissioners in each county was required within six months after the passage of the act to prepare duplicate road maps of all public roads in the county as well as public roads constituting boundaries between counties and designate on the map such roads as the county board considered of sufficient importance to justify their improvement under this act. One of the maps was filed with the county clerk and the other forwarded to the State highway commission with a statement of the location in the county of all deposits of road material. If the county board failed to carry out the provisions of the act, the State highway commission might proceed to obtain the information and deduct the amount thus expended from the first apportionment to such county.

The State highway commission was required to prepare a map showing all public roads in each county, and all roads which the commission deemed of sufficient importance to entitle them to

State aid. The commission might in coöperation with the county commissioner divide the roads into two classes, one of primary importance and the other of secondary importance, the primary roads to be the first improved.

A State highway fund was created consisting of \$5000 direct appropriation to pay the expenses of the commission until the amount credited to the State highway fund was available, thereafter the expenses of the highway commission to be paid out of the said highway fund. Each county is required to levy an annual road tax of not less than 2 mills or more than 5 mills and a road poll tax of \$2; the money thus raised forms the general road fund of the county. Each county may also levy a special tax not exceeding $2\frac{1}{2}$ mills for constructing and maintaining bridges. Two-thirds of all receipts of a county from forest reserve funds must be credited to its general road fund.

The act states that on or before the first Tuesday of March of each year the highway commission shall apportion the State highway fund among the different counties of the State and notify their respective boards of county commissioners. The highway commission is given discretion as to the amounts to be apportioned to the representative counties and is required to take into consideration the area of the county, the amount of money to be expended by it, the difficulty and expense of road construction and extraordinary expenses connected with the development of new territory. The commission is not allowed to spend any of the funds within the corporate limits of cities or towns or in any of the counties in which the county commissioners have not provided for the raising of an amount equal to the amount set aside by the State highway commission. If any county within ninety days fails to avail itself of the act, the highway commission may apportion its allotment among the other counties. The commission is authorized to adopt rules and regulations for the construction and maintenance of State roads. The board of county commissioners is required to make the necessary surveys, plans, specifications and estimates for State roads, in accordance with rules and regulations of the State highway commission, which is authorized to approve or disapprove of the same. The actual construction or maintenance of State roads is under the direction of the State highway commission. The boards of county commissioners may for such work employ a competent civil engineer at not to exceed \$12 per day. Contracts are let by the boards of county commissioners.

The boards of county commissioners are required to make a report on or before December 30 of each year to the State highway commission showing in detail all money expended by such

county during the current year in the construction and maintenance of the public roads. One part of the report shall cover State roads and the other portion cover all other roads.

The State highway commission is required to make a biennial report to the governor.

Local Road Legislation

Jurisdiction over roads vests in elected boards of county commissioners, who appoint a county surveyor and divide the counties into districts with one or more overseers in each. Special bridge and road districts may be created by election but the taxes are levied and collected by the county boards.

Road Bond Legislation

The board of county commissioners of any county may issue coupon bonds in an amount which, with the outstanding bonded indebtedness, will not exceed 5 per cent of the assessed valuation of the taxable property therein; provided that no county shall incur any indebtedness or liability for any single purpose to an amount exceeding \$10,000, without the approval of a majority of the electors thereof.

Convict Labor Law

County commissioners may require prisoners to labor "on the public works or ways in the county."

Under the State highway commission, act of 1913, county commissioners may have work done by prison or convict labor on State roads in their county.

Automobile Registration

The law provides for registration with the secretary of State. Schedule of fees is as follows: All motor vehicles, \$2; chauffeur's license, perpetual, \$2.

The net registration revenue is paid into the State treasury and credited to the State highway fund, to be expended in constructing State roads and for apportionment to the several counties of the State.

Highway Officials

State Highway Commission, A. W. Mahon, Helena, State engineer, chairman; Geo. R. Metlen, secretary; Prof. L. D. Conklin, Bozeman.

Progress Report

The Department of Highways furnished plans and specifications for about 100 bridges in 1915, and supervised all bridge work in the State.

Road Funds

In 1915, \$986,066 was spent on bridges, and there were \$215,842 outstanding bridge warrants; there was a balance in the bridge fund of \$657,625. There was spent from the road fund, \$2,675,906 and there were \$1,076,882 outstanding road warrants; there was a balance of \$1,147,124 in the road fund. It is expected that expenditures will be somewhat larger in 1916 than in 1915. In addition several counties are contemplating bond issues for hard surfacing, none of which has been done yet in the State.

Publications

Montana Good Roads Convention
Minutes of proceedings, Billings, Mont., 1910.
State Office of Farmers' Institutes
Montana Farmers' Bulletin 2. Better roads.
Montana Highway Commission
Specifications for maps and surveys, 1914.
Montana Highway Commission
Road Pamphlet 1. Road Drag, 1914.
Montana Road Pamphlet 2. Drainage.

[Approved by A. W. MAHON, State Engineer.]

NEBRASKA*State Aid Legislation*

The county boards of commissioners are required to have bidders on bridge work use forms provided by the secretary of State board of irrigation. The county boards are forbidden to let a contract for a bridge costing over \$500 except upon plans and specifications of the secretary of the State board of irrigation, who is required also to inspect and check that completed work.

The State board of irrigation is constituted by law. The State board of supervision for bridges and the State engineer are empowered to carry out the orders of the board.

The board of county commissioners may make application to the State board of irrigation for State aid in the construction of any bridge over a stream of 175 feet or more in width, pledging the county to furnish one-half the cost of construction, and, if the application is approved by the State board, the contract is let jointly by the said county board and the State board of irri-

gation. The plans and specifications are furnished by the State engineer and the construction is under the joint supervision of the State board of irrigation and the board of county commissioners. A State levy of one-fifth of 1 mill on the dollar constitutes the "State aid bridge fund."

The State board of irrigation, highways and drainage is empowered to advise with county boards on highways and bridges. The board appoints an advisory board of three members authorized by law to supervise the expenditure of any funds that may be provided by the federal government for highway and bridge construction.

Local Road Legislation

In some counties, the board of county commissioners divides the county into districts, in each of which an overseer is elected annually; the board appoints a county highway commissioner annually. In the other counties, each county is divided into seven districts, in each of which the electors choose a road supervisor.

Road Bond Legislation

Any county, township, precinct, city, or village may issue bonds to construct a highway bridge across any boundary river of the State, if so voted by three-fifths of the voters at a special election. The amount of bonds must not exceed 10 per cent of the valuation. In any county, township, precinct, city or village which has made donations to railroads or other internal improvements, a two-thirds vote shall be required for such bonds. The interest shall not exceed 7 per cent. There shall be an annual tax for interest and sinking fund. The term of the bond is not designated.

Similar provision is made for purchasing private bridges within any township or across any river bounding a township. For such purpose a two-thirds majority is required and the bonds shall bear not to exceed 8 per cent interest. A yearly tax must be levied to pay 5 per cent of the principal annually and the interest on the bonds. Any county or city in the State is authorized to issue bonds for internal improvements, and it appears that such improvements include highways.

Convict Labor Law

For the purpose of enabling the county commissioners to employ in a profitable manner all convicts sentenced to hard labor, the board has authority to make rules and regulations and designate the place where the convicts shall work. The county jail is declared to extend to any quarry, road or other place the commissioners may designate.

Automobile Registration

Annual registration fee, \$2 for motor cycle, \$3 for automobile, \$5 for commercial truck, \$5 for dealer. About four-fifths of the proceeds is paid into the road-dragging funds of the counties where the fees are obtained.

Highway Officials

State Engineer.—Geo. E. Johnson, Lincoln; W. D. J. Steckelberg, assistant State engineer, Lincoln.

Progress Report

The time of the State engineer devoted to highway work in 1915 was spent mainly on preparing standard bridge plans for 15-ton and 20-ton roller loads.

Road Funds

There is a State tax of 0.2 mill for aid toward bridge construction and maintenance, which is estimated to furnish \$75,000 in 1916.

Publications

State University. Agricultural Experiment Station
Press Bulletins. No. 33. Construction and use of the road drag.
L. W. Chase.

[Approved by GEORGE E. JOHNSON, State Engineer.]

NEVADA*State Aid Legislation*

A law passed by the legislature of Nevada, and approved by the governor March 16, 1911, provided that the State engineer should have general supervision of road work carried on by convict labor. An appropriation of \$20,000 was made to cover the work, which was of the nature of an experiment. No later appropriations have been made.

Local Road Legislation

The local roads are under the jurisdiction of the boards of county commissioners, which divide the counties into districts with one or more overseers in each.

Road Bond Legislation

On a majority vote of the qualified electors of any county, the board of county commissioners may issue bonds of the county to create a fund to be known as the "county road and bridge fund," to be used in the construction, repair, and maintenance of the county roads and bridges, and the purchase of necessary implements and machinery for this purpose. The amount of these bonds shall not exceed the equivalent of 3 per cent of the total assessed valuation of the real and personal property in the county. The bonds shall have interest coupons attached, shall bear not to exceed 6 per cent interest, shall be in denominations of \$1000, \$500 or \$100, as determined by the board of county commissioners, and shall be numbered consecutively from first to last, and must not be sold for less than par. On January 1 of the third year succeeding their sale and annually thereafter, one or more of these bonds, as shall be designated by the board, in consecutive order, shall be paid and redeemed by the county, and an annual tax shall be levied to pay the interest on them and to create a sinking fund for their retirement.

Convict Labor Law

The State prison commissioners are authorized to detail for work on the public highways any male convict in the State prison who may be properly detailed, except prisoners under sentence of death, provided, that such detail shall be voluntary on the part of the convict.

Convicts so detailed are not required to wear stripes, are given ten days off sentence for each month's faithful work, and are paid 10 cents per day.

Automobile Registration

The law provides for annual registration with the secretary of State. The registration fee is 12½ cents per h.p., minimum fee, \$2.50. Motorcycles exempt.

The net registration revenue, when it aggregates \$25,000, shall be apportioned to the several counties of the State for construction of county roads under the joint supervision of the county commissioners and the State engineer. (Chapter No. 206, Laws 1913.)

Highway Officials

The State engineer no longer has any connection with road work, which is under the county surveyors and road overseers.

[Approved by W. M. KEARNEY, State Engineer.]

NEW HAMPSHIRE

State Aid Legislation

In 1915, the legislature abolished the office of State engineer and created a State highway department, in charge of a highway commissioner appointed for five years by the governor. He has charge of the location, construction and maintenance of roads built in part or wholly with State funds. All technical features of the work, the award of contracts and the supervision of construction are under his control, but the taking of land or materials by eminent domain is under the governor and council. Appeals from his decisions may be taken to the governor.

Prior to 1915, three north and south trunk lines and three cross lines were authorized. In 1915, eleven more cross lines were authorized. All State-aid funds spent in the cities and towns through which these roads pass must be expended on these roads until they are finished. The State contributes toward such work one-half the cost and such further sums, in towns unable to pay half the cost, as the highway commissioner considers equitable. The work is done by the local authorities; if they neglect it, it may be done under the direction of the highway commission and the proper proportion of the cost must be raised by a proportionate addition to the State tax levy for that city or town, the assessment not to exceed $2\frac{1}{2}$ mills or an average of \$2500 per mile of road improved.

Aside from the State highways the State grants aid to the towns on the following plan:

Each town, out of the money raised for highway purposes, shall set aside the following amount for the improvement of its highways under the supervision of the State engineer: Towns having a valuation of less than \$2,000,000, \$1 on each \$1000 valuation; towns of \$2,000,000 and less than \$3,000,000 valuation, 75 cents on each \$1000 valuation; towns of \$3,000,000 and less than \$5,000,000 valuation, 50 cents on each \$1000 valuation; towns of \$5,000,000 and less than \$15,000,000 valuation, 33 $\frac{1}{4}$ cents on each \$1000 valuation; towns from \$15,000,000 and upward valuation, 25 cents on each \$1000 valuation; counties in which are located unincorporated towns, \$1 on each \$1000 valuation. If a town desires State aid for permanent improvement in addition to the improvement provided by the foregoing method, it shall raise an additional amount equal to 50 per cent of this sum and then make application for State aid. They shall then receive for each additional dollar so set apart the following amounts: Towns having a valuation of less than \$100,000, \$3 for each \$1 so set apart; \$100,000 and less than \$150,000, \$1.25

for each \$1; \$250,000 and less than \$500,000, 60 cents for each \$1; \$500,000 and less than \$1,000,000, 40 cents for each \$1; \$1,000,000 and less than \$3,000,000, 25 cents for each \$1; \$3,000,000 and upward, 20 cents for each \$1.

The amounts thus set aside by the towns, respectively, constitute a joint fund for permanent improvement.

The State road funds for trunk lines are provided by State bonds bearing not to exceed 3½ per cent interest. A direct appropriation is made annually for paying interest and installments on the bonds. The regular State aid not on trunk lines is met by current appropriations.

Local Road Legislation

County boards have jurisdiction over county roads and the boards of selectmen have charge of all township roads. A part of the property road tax is rebated to persons complying with the wide-tire laws.

Automobile Registration

The law provides for annual registration with the commissioner of motor vehicles. The schedule of fees is as follows: Motor cycles, \$2. Automobiles, 15 h.p., and less, \$10; 16 to 30 h.p., \$15; 31 to 40 h.p., \$20; 41 to 50 h.p., \$25; 51 to 60 h.p., \$30; 61 h.p. and over, \$40. Motor trucks and automobiles used for carrying passengers for hire, on same basis.

The net registration revenue shall be expended in the maintenance of highways in accordance with the State highway laws, provided that 35 per cent of such net revenue may be expended in the maintenance of roads in cities, towns and places where roads are not ordinarily maintained with assistance of the State. Fines and forfeitures are paid into the State treasury for use in the same manner as registration revenues.

Highway Officials

State Highway Department, Concord.—F. E. Everett, State highway commissioner; C. C. Howe, chief clerk.

Assistant Engineers.—F. W. Brown, Concord; W. A. Grover, Dover; H. L. Smith, Lakeport; C. M. Brooks, Keene; O. M. James, Northwood Narrows; C. H. Chandler, Whitefield; C. P. Riford, Concord; F. H. Colburn, Concord.

Progress Report

During 1915, 145.50 miles of road were improved, comprising 11.13 miles of grading, 125.22 miles of gravel roads, 4.34 miles of

macadam, and 4.81 miles of bituminous macadam. The average costs of this work were \$3,815 per mile for grading, \$3,562 for gravel roads, \$5,129 for macadam roads and \$13,392 for bituminous macadam roads.

There are 15,116 miles of roads in the State, of which 1177 miles have hard surfacing.

Road Funds

For construction purposes in 1915, \$274,186 72 was spent by the State, in connection with which the towns spent \$295,179.97, a total of \$569,366.69.

For maintenance purposes in 1915, the State spent \$334,186.20, in connection with which the towns spent \$151,904.23, a total of \$486,090.43. The average cost per mile for trunk line maintenance was \$464.97 and for State aid maintenance \$164.54.

About the same amount of money will be available in 1916.

Publications

State Engineer

Biennial reports of the governor and council, and of the State engineer relative to highway improvements, 1905-06 to 1911-12.

Agricultural Experiment Station

Bulletin 30. Experiments in road making. C. H. Pettee.

Bulletin 46. Road construction and maintenance in New Hampshire.

Bulletin 77. Road construction in New Hampshire.

State Legislature. House

Journal, 1893. Report of committee on roads, bridges, and canals accompanying joint resolution for appropriation for highways.

State Board of Agriculture

Making and repairing roads. M. Humphrey, 1872.

Annual report, 1894-96. Proceedings of first good roads convention.

State Bureau of Labor

Biennial report, fourth, 1901-02. New Hampshire highway statistics with tables showing by town and county, taxes assessed for all purposes, amount expended on highways, amount expended for repairing of highways in summer, amount expended in breaking roads in winter, number of miles of highway, daily wages, etc.

State Engineer

Biennial Report 1905-06 to 1909-10.

Biennial Report State Superintendent of Highways 1911-12.

[Approved by S. E. EVERETT, State Highway Commissioner.]

NEW JERSEY

State Aid Legislation

The State highway commission consists of the governor, president of the senate, speaker of the house of assembly, the State treasurer, who serve without compensation, and the commissioner of public roads.

The commission is required to establish a continuous State highway system of improved main traveled roads connecting counties, cities, seaside resorts, large centers of population, outlets at the boundaries of the State, the Ocean Highway, and the Delaware River Drive, and the State commissioner of public roads is directed to submit to the commission a map showing the proposed system, the aggregate mileage of which shall not exceed 1500 miles.

The commissioner of public roads is appointed by the governor for three years. His staff is composed of civil-service employees who hold office, unless removed for cause; a State highway engineer who is chief engineer; and four division engineers, ten regular inspectors and foremen who are intended to form the nucleus for a trained corps of inspectors. In addition to this force the commissioner may appoint a local supervisor or inspector when necessary on each contract at a minimum compensation of \$3 per diem. All of the staff are under civil service rules and regulations.

The State commissioner of public roads is directed to take charge of the construction, improvement, and maintenance of the State highways comprising the State highway system, all such work to be done at the expense of the State, or upon the basis of an equitable agreement between the county authorities and the commission, the plans and specifications to be prepared by the State highway department and supervision to be exercised by the department.

The commissioner of public roads is intrusted with the execution of the law granting State aid in the improvement of highways, such highways being in addition to the State highways. The commissioner, after conference with the board of chosen freeholders in respective counties and other local authorities, passes upon requests for aid in road improvement. The surveys, plans, estimates, and specifications are made locally, but must be approved by the State commissioner of public roads before the local authorities advertise for bids. Later the contracts and bonds are examined and approved by the commissioner before work begins. After the work has been completed to the satisfaction of the local authorities a written statement with detailed cost data is submitted to the commissioner, and if after inspection it is approved by him the State's portion of the cost, amounting to 40 per cent, is sent to the county.

After final approval by the State commissioner of public roads such roads shall thereafter be county or municipal roads, to be maintained by the county board of freeholders and the county supervisor or by the township or municipal officers. If the county fails to repair the road within 60 days after notice in writing by the State commissioner, he shall certify such neglect to

the State comptroller, who shall withhold payment to the county of any money that may be apportioned to it until such repairs are made. The State road fund includes appropriations made by the legislature and the receipts from motor vehicle licenses and fines.

The commissioner of public roads may grant aid in the construction of bridges on roads being improved to the extent of 20 per cent of their cost, otherwise the State takes no part in the cost of building or maintaining bridges, the only exception being the bridge over the Raritan River to Perth Amboy, for the maintenance of which the State pays one-third in accordance with the terms of a statute passed in 1912.

Local Road Legislation

The county roads are under the board of chosen freeholders of the county, which appoints a county road supervisor and a county engineer in charge of the bridges and roads.

Road Bond Legislation

The board of chosen freeholders may issue bonds of the county in an amount, including existing indebtedness, not to exceed 3 per cent of the assessed value of the real estate therein; provided that in no case shall the amount of such bonds outstanding at any one time exceed \$300,000. Such bonds shall bear not to exceed 5 per cent interest and shall run for not to exceed 40 years. Before issuing such bonds, the board of chosen freeholders shall make written application to the circuit court for authority to issue the bonds, which court shall investigate and determine whether or not the issue shall be made.

The board of chosen freeholders of a county, the township committee of a township, or the proper governing body of other municipality, may, by resolution, issue bonds thereof to pay the share of such county, township, or other municipality in the cost of State-aid road work therein. Such bonds shall bear not to exceed 5 per cent interest and shall run for not exceeding 30 years.

The board of chosen freeholders of any county is authorized to repair or reconstruct county roads and to issue bonds in payment of the cost thereof. Such bonds shall bear not to exceed 5 per cent interest and shall be payable at any time not exceeding 5 years from date of issue.

When a navigable stream marks the dividing line between two or more counties and the boards of chosen freeholders of such counties, respectively, shall have resolved, or may resolve, that a bridge across such stream is a public necessity, or that

an existing bridge across said stream should be rebuilt, the same may be done by the said boards of chosen freeholders jointly, the expense thereof to be borne by such counties in such proportions as may be agreed upon by the said boards of chosen freeholders. If desirable, bonds may be issued by each county for its proportionate share of the cost of such bridge. Such bonds shall bear not to exceed $4\frac{1}{2}$ per cent interest and run for not exceeding 30 years.

To meet the expenses incurred for the acquisition, development and improvement of parks and parkways in any county, the board of chosen freeholders may, from time to time, in addition to any bonds theretofore authorized by law, on the requisition of the board of park commissioners, borrow money by issuing the bonds of said county, not exceeding in the aggregate \$650,000, to run for not exceeding 50 years and to bear not to exceed $4\frac{1}{2}$ per cent interest.

It is provided (Chapter 245, L. 1914) that a commission may be appointed for three or more contiguous counties to construct one or more bridges or tunnels over or under a navigable stream or river which forms a part of the boundary of the State, and such counties may, respectively, issue bonds to meet the cost thereof. Such bonds shall be issued in such amounts and shall bear such interest, not exceeding 5 per cent, and be payable at such time as the governing bodies of such counties may, by resolution, determine.

Convict Labor Laws

The board of chosen freeholders of any county may order the sheriff to cause all able bodied male convicts or so many as may be required, to be put to work on the public roads of the county.

The management of the State prison shall be vested in a board of inspectors, consisting of six members, to be appointed by the governor with the advice and consent of the senate. The said board of inspectors is authorized to enter into an agreement with the State commissioner of public roads, or other department of the State government, for the employment of prisoners on public work.

The State commissioner of public roads, or the board of chosen freeholders of any county may make application to the prison labor commission for convicts to work on public highways. The prison labor commission in conjunction with the governing body of the penal institution determine the number to be assigned the cost of maintenance and compensation and may enter into an agreement for the payment of costs or any portion thereof.

The prison labor commission is authorized to acquire so much

land for agricultural and quarry purposes as may be selected by said commission, and transfer prisoners for agricultural purposes, and to be employed in the quarrying and preparation of building and road materials.

Automobile Registration

The law provides for annual registration with the assistant secretary of State, who is ex-officio commissioner of motor vehicles. The schedule of fees is as follows: 10 h.p. and less, \$4.50; 11 to 29 h.p., \$7.50; 30 h.p. and above, \$15; motor cycles, \$2; motor trucks weighing over 4000 pounds, in addition to regular fees, \$10; dealers and manufacturers for each car demonstrated, \$5; operators, including owners, for cars not exceeding 30 h.p., \$2; operators, including owners, for cars exceeding 30 h.p., \$4; motor vehicle line carrying passengers operating from and adjoining State, \$100.

The net revenue derived from registrations, fines and penalties shall be deposited in the State treasury for use in repairing the more important improved roads of the State, under the direction of the commissioner of public roads. (Chapter No. 113, Laws 1906 as amended to January 1, 1915.)

Highway Officials

State Department of Public Roads, Trenton.—Edwin A. Stevens, State road commissioner; Robert A. Meeker, State highway engineer; Division Engineers in Charge of Roads, E. M. Vail, E. E. Reed, Roy Mullins; Division Engineer in Charge of Bridges, Lloyd McEntire.

Progress Report

During the fiscal year ending October 31, 1915, there were accepted 52.929 miles of new road which cost, including bridges, \$721,943.73; the State's share of this sum was \$301,891.51. There were carried into the present year 33 road and 15 bridge contracts, embracing 108.947 miles of road and costing about \$1,338,807, of which sum the State's share is \$492,730.

There was spent on convict road labor \$82,054, and there was carried over on unpaid requisitions \$26,498.

The total expenditure of the State for repairs was \$751,277 and there was carried over into the current year repair work on which the State's share will be \$522,385.

The total expenditure of the State for all road purposes, including administration, was \$1,263,246.

Road Funds

The State appropriations for the year ending October 31, 1916, are: State road fund, \$500,000; convict labor, \$65,000; department expenses, \$17,500; salaries, \$16,150; survey, \$6,500; total \$605,150. The estimated receipts of the motor vehicle fund for the same period are \$1,200,000.

Publications

Commissioner of Public Roads,
Annual reports, 1894 to 1914.
Agricultural Experiment Station
Report for 1901. Road construction.

[Approved by Col. E. A. STEVENS, Commissioner of Public Roads.]

NEW MEXICO*State Aid Legislation*

The State highway commission consists of the governor, the commissioner of public lands and the State engineer, all of whom serve without compensation. The commission is required to meet four times a year, in January, March, June and September, and hold such special meetings as they consider necessary. The commission has general supervision of all highways and bridges constructed or maintained wholly or partly by the aid of State money. The commission is required to construct, prepare and maintain at the expense of the State either wholly or in part such public roads as best serve the interest of the general public, looking to the construction and maintenance of a complete system of highways. The commission is directed to investigate the needs of the various localities and to coöperate with the various boards of county commissioners in road construction.

In order to provide State aid fund an annual tax is levied not to exceed 1 mill on each dollar of taxable property, the sum thus realized to be turned over to the State treasurer and constitute the road fund which is subject to the orders of the highway commission. State highway bonds are also issued.

The commission is required to make an annual report on or before January 1.

The State engineer is the engineer of the highway commission, and subject to its orders, has supervision of the construction and maintenance of all highways and bridges under the State aid act and also has supervision of all county bridges built by contract where the amount exceeds \$1000.

The commission is authorized to do educational and investigative work.

In extending State aid preference is to be given by the commission to those counties which shall contribute an amount at least equal to that appropriated by the commission.

Certain specific State roads are provided for by State legislation.

Local Road Legislation

In 1912 an act was passed in New Mexico creating a county road board in each county to serve without compensation and to consist of three members, to be appointed by the State highway commission for a period of three years and to be subject to removal by the commission for cause. The county road boards are required by law to make an annual report to the State highway commission.

Local Bond Legislation

When petitioned by not less than 10 per cent of the qualified electors of the county who are taxpayers, the board of county commissioners may submit the question of issuing bonds of the county for road purposes. A majority of those voting is required. The amount of the bonds shall not exceed in the aggregate, including existing indebtedness, 4 per cent on the value of the taxable property within the county, shall bear not to exceed 5 per cent interest, and shall run not to exceed thirty years, but may be made redeemable prior to the date of their maturity, as may be provided by order of the board of county commissioners. An additional annual tax levy shall be made to meet the interest charges on the bonds, and there shall be created a fund to be known as the "county highway sinking fund," which shall be used for the redemption of bonds so issued.

Convict Labor Law

Aside from the special acts of the legislature which provides for building certain roads by convict labor, a general act of 1909 provides that the State highway commission shall employ such convict labor as shall be available and advisable. The board of penitentiary commissioners shall on demand of highway commission furnish available convicts and also necessary guards, provided that the cost of transportation, maintenance and guarding while engaged in road work shall be paid from the road fund.

Automobile Registration

The law provides for the annual registration with the secretary of State. The schedule of fees is as follows: Less than 12 h.p., \$2; 12 to 19 h.p., \$4; 20 to 29 h.p., \$6; 30 to 39 h.p., \$8; 40 to 49 h.p., \$10; 50 h.p. and over, \$12; dealers and manufacturers, \$12.

The net registration revenue shall be paid into the State treasury and half credited to the State highway fund for expenditure upon the public highways of the State, preference being given to automobile routes and the other half paid to the counties from which it is derived.

Highway Officials

State Highway Commission, Santa Fe.—Wm. C. McDonald, governor; Robert P. Ervien, land commissioner; James A. French, State engineer.

Progress Report

During 1915, the State highway commission built 95 miles of graded roads with gravel surfacing, 41 miles of graded roads without surfacing, and 40 miles of machine-graded mesa roads.

Road Funds

During 1916, about \$600,000 will be available for the State highway commission, and about \$393,500 for county road work.

Publications

Territorial Engineer.

Second biennial report to the governor. Construction of good roads, p. 165. Cost of road construction, p. 176.

State Engineer.

State Roads Commission.

Annual report, 1912.

[Approved by JAMES A. FRENCH, State Engineer.]

NEW YORK

State Aid Legislation

The State commission of highways consists of a single commissioner who is appointed by the governor with the consent of the senate for a period of five years.

The commissioner of highways appoints a secretary, auditor, and three deputy commissioners. Each of the deputy commissioners has had practical experience in the actual building, construction, and maintenance of highways and is familiar with the operations and effect of State statutes relating to highways and bridges.

The first deputy is a practical civil engineer, whose duties relate to the plans, specifications, and execution of all contracts awarded by the department.

The second deputy's duties relate to the maintenance of State and county highways, and the third deputy's duties relate to the improvement and maintenance of town highways and bridges. The commissioner has general supervision of highways and bridges constructed or maintained in whole or in part by the aid of State money; aids district, county, and town superintendents by advice and information; investigates methods of road construction and maintenance; compiles statistics, including highway map of the State; holds public meetings, etc. The State is divided by the commission into not more than nine divisions, each in charge of a division engineer who, under the direction of the commission, makes surveys, plans, specifications, and estimates for the construction and maintenance of highways in his division constructed wholly or in part by the aid of State money. All State and county highways on which the State expends money are inspected annually and a report prepared showing their condition, the improvements necessary, and the estimated cost, and a report made annually to the legislature setting forth the amount required for maintenance for the ensuing year.

The highways of the State are divided into four classes, namely, State highways, improved and maintained at the sole expense of the State; county highways improved and maintained at the joint expense of the State, county and town; county roads improved and maintained by the county; and town highways improved and maintained by the town with the aid of the State.

The system of State highways is defined by law and the routes described. Such highways are to be improved from the funds from the sale of State bonds. The board of supervisors of any county may request that a certain designated highway be improved as a county or State highway. If the State commission of highways approves the request, it shall cause the division engineer to prepare plans and specifications, which are then sent to the division or county superintendent, who personally examines the highway and makes his recommendation to the commission. The commission may then finally adopt the plans and estimates and, if it be a State highway, advertise for bids and award contracts. If it be a county highway, the plans and estimates are transmitted to the board of supervisors for final approval.

The performance of every contract for State and county highways is under the supervision and control of the State commissioner of highways. When the board of supervisors of a county requests the improvement of a county highway it shall make appropriation of the county's share of the cost of such improvement. After final payment under contract the State commission files a statement of cost with the county treasurer,

who thereupon pays upon the request of the commission the county's share as follows: 2 per cent of the cost of each \$1000 of assessed valuation of real and personal property in the county for each mile of public highway in such county, not to exceed 35 per cent of the cost for the county. The maintenance of State and county highways is under the direct supervision of the commission, which also has authority to provide for a system of patrol of highways, the patrolman to be appointed by the State commissioner of highways. Each town pays for the maintenance of State and county highways annually \$50 for each mile of said highway within the town.

The State annually contributes to the expense of maintenance of county roads which have been constructed without expense to the State 50 per cent of the amount appropriated by the county for the maintenance of such roads.

The State contributes to town highways on the following basis: (1) Where the assessed valuation of the town is less than \$5000 for each mile of highway in such town, outside of incorporated villages, an amount equal to the amount of taxes raised for highways; (2) where the assessed valuation is \$5000 or over and less than \$7000 per mile an amount equal to 90 per cent of such taxes; (3) where the assessed valuation is \$7000 or over and less than \$9000 per mile an amount equal to 80 per cent of such taxes; (4) \$9000 or over and less than \$11,000, an amount equal to 70 per cent; (5) \$11,000 or over and less than \$13,000, an amount equal to 60 per cent; (6) \$13,000 or over, an amount equal to 50 per cent. No town shall receive in one year an average of more than \$25 per mile for the total mileage of roads outside of incorporated villages, and the amount which is raised by local taxation shall be such as will, when added to the amount received from the State, be not less than \$30 for each mile of highway in the town.

A State bond issue of \$50,000,000 was authorized in 1906 and an additional State bond issue of \$50,000,000 in 1912. The bond issue was originally intended for the improvement of a system of county highways aggregating 8,380 miles, and to this was added a system of State highways aggregating 3,617 miles. The recent \$50,000,000 bond issue is to be expended as follows: \$20,000,000 for the construction and improvement of State highways and \$30,000,000 for the construction and improvement of county highways. The apportionment among the counties is on the basis of population, the measured mileage of public highways outside of cities and villages, and the total area, each factor having a weight of one-third. Direct appropriations are made by the legislature for maintenance.

Local Road Legislation

New York has a rather centralized system in that the State highway commission, by reason of its extending aid to counties and townships, exercises a limited supervision over practically the entire road mileage of the State. In the counties the governing body is the board of supervisors, and in the townships the township board. The county superintendent of roads is appointed by the county board of supervisors, but in the event they fail to make such appointment, then the State highway commission makes the appointment or includes the county in a district and appoints a district superintendent. The term of office of the superintendent is four years, but he may be removed by the State highway commission upon written charges. Such superintendent is subject to the rules and regulations of the State highway commission. The towns elect biennially a town superintendent of highways who has supervision of the highways therein, subject to the regulations of the State highway commission. The State grants aid in the construction and maintenance of practically every type of road in the State, and the various road officials conduct their work in accordance with the regulations prescribed by the State highway commission.

Local Bond Legislation

The county board of supervisors may, by resolution, authorize the issuance and sale of bonds for paying the county's share of the cost of any highway. These bonds must not be sold for less than par, and the amount of the issue must not increase the total county indebtedness to more than 10 per cent of the assessed valuation.

For the purpose of purchasing toll roads and bridges, the county board may issue bonds which shall bear interest not exceeding 5 per cent, shall run not longer than twenty years, and shall not be sold below par.

Towns may issue bonds for road purposes when authorized by the county board of supervisors. In the case of towns, a majority vote may increase the amount of issue to one-third of the assessed valuation of the town.

Convict Labor Legislation

The town superintendent with the consent of the town board may request the supervisor of the town under the provisions of section 93 of the county law to procure the services of the prisoners serving in the county jail for general work on the public highways of the town.

The board of supervisors of a county, or the town board of a town in which any portion of a county or State highway is situated, may, on behalf of such county or town, present proposals and be awarded a contract for the construction or improvement of such highways, in accordance with the provisions of law. If such contract be awarded to a board of supervisors or a town board, such board shall, by resolution, designate some suitable person, or persons, to carry into effect such contract and to transact all necessary business in respect thereto, and such board may, by resolution, direct the person, or persons, so designated to apply to the superintendent of State prisons for convict labor in the construction of such highway or section thereof. The resolution shall specify the maximum number of convicts to be applied for. The superintendent of State prisons shall detail for labor, pursuant to such resolutions and requests, such number of convicts as shall be available therefor not exceeding the number applied for. Such convicts shall be in the immediate charge and custody of the officers and guards detailed by the superintendent of State prisons, and shall at all times be subject to the control of such superintendent, except that the work to be done shall be directed by the engineers and foremen of the State highway department. The expense of maintenance of such convicts shall be paid by the county or town entering into such contract, from funds due thereon to such municipality.

The prison labor commission is authorized to acquire so much land for agricultural and quarry purposes as may be selected by said commission, and transfer prisoners for agricultural purposes, and to be employed in the quarrying and preparation of building and road materials.

Civil Service Law Applicable to Road Officials

The State commissioner of highways shall appoint such resident engineers, district superintendents, clerks, officers and employees as may be required, subject to the civil service law and other provisions of law, within the amount appropriated therefor, unless the appointment of such clerks, officers, or employees is otherwise provided for by law. District superintendents, appointed as provided in this chapter, shall be appointed from lists prepared from examinations which shall test their qualifications for the actual construction and maintenance of highways and their executive capacity, rather than their scientific attainments. Clerks, other than those employed in the principal office of the commissioner of highways, inspectors, and other employees in the department, whose duties pertain to the maintenance of highways, shall likewise be selected from lists

prepared from examinations, testing their general knowledge of the highway law and of the practical construction of highways. Inspectors of construction, other than engineers and levelers, shall be selected from lists similarly prepared, except that they shall be residents of the county within which the highway constructed or improved is located. To the end that the employees of the department of highways engaged in the work of constructing, improving, or maintaining highways under the provisions of this chapter may be practical highway builders, the commissioner of highways is authorized to indicate to the civil service commission the relative value which should be given to experience and scientific attainments. The commissioner of highways, subject to the provisions of civil service law, may remove the division engineers, resident engineers, district superintendents, clerks, officers and employees of the department.

Automobile Registration

The law provides for annual registration with the secretary of State. The schedule of fees is as follows: 25 h.p. or less, \$5; 26 to 34 h.p., \$10; 35 to 49 h.p., \$15; 50 h.p. and above, \$25; all motor vehicles used for commercial purposes only, \$5; dealers and manufacturers, \$15; chauffeur's license, \$5; motor cycles exempt.

The revenue derived from registrations, fines and forfeitures is paid into the State treasury for appropriation to be used for maintenance and repair of improved roads of the State under the direction of the State highway commission. (Chapter No. 374, Laws 1910, as amended in 1911.)

Highway Officials

State Commissioner of Highways.—Edwin A. Duffey; first deputy commissioner, H. Eltinge Breed; second deputy commissioner, Fred W. Sarr; third deputy commissioner, Benjamin J. Rice; auditor, Sephrine D. Gilbert; secretary, Irving J. Morris; assistant secretary, Frank R. Pennock, Albany.

Progress Report

During 1915, contracts were awarded for 1073 miles of State and county highways, for which the State appropriation was \$11,994,467, the county appropriations \$3,043,277, and the city and village appropriations \$702,630, a total of \$15,740,374.

During 1915, 759 miles were completed and officially accepted and 324 miles were completed but not accepted, a total of 1083 miles built during the year. There were 739 miles of unfinished road under contract on January 1, 1916.

The designated State and county highway systems have a total length of 11,988 miles, of which 7388 miles are completed or under contract.

Road Funds

A bond issue of \$50,000,000 was voted in 1906 and another in 1912, and \$75,000,000 of these issues has been spent or is obligated. The department has requested the legislature to sell \$10,000,000 of the remaining bonds for construction purposes, and to make the following appropriations from the general State funds: \$3,522,792 for maintenance and repair of State and county highways improved by State aid, \$100,000 for the maintenance and permanent improvement of roads built with county funds, \$40,000 for the maintenance of roads within Indian reservations, and \$1,943,000 for the maintenance and improvement of town highways. It is expected that about \$2,500,000 will be raised by the towns and counties for local road work. The total highway expenditure is estimated at \$18,000,000.

Publications

State Department of Highways

Proceedings of the first to third semi-annual conference of the State commission and county superintendents of highways of the State of New York, 1909-10.

State Department of Highways. Bureau of Research

Annual Report, 1909-10. Two volumes.

State Commission of Highways

Reports, 1909, 1910, 1911, 1912.

State Commission of Highways. Bureau of Town Highways

Bulletin 1. Practical suggestions and directions to highway officials relating to construction and improvement, repair and maintenance of town highways and bridges.

State Engineer and Surveyor

Annual report, 1899. History of road improvements during year; arranged by roads.

Annual report, 1899. Engineer's suggestions regarding employment of prison labor to improve public highways of State.

Annual Reports, 1901, 02. Suggestions regarding improvement of various State highways funded by means of issuing State bonds bearing interest and to be redeemed in course of seventeen years from issue.

Annual reports, 1902, 03. Proceedings of third and fourth annual good roads convention of board of supervisors of New York State held at Albany.

Annual reports, 1902, 03. Compilation of laws for improvement of public highways.

Annual reports, 1904, 1905, 1906, 1907, 1908.

Bulletin 1. Improvement of public highways (1899).

Bulletin 2. Improvement of public highways (1899).

Bulletin 3. Improvement of public highways. Instructions for obtaining State aid in the improvement of public highways (1901).

Bulletin 4. Issued by U. S. Department of Agriculture as Public Roads Inquiries Bulletin 22.

- Bulletin 5. Proceedings of fourth annual supervisors' highway convention of State of New York (1903).
 Bulletin 6. Proceedings of fifth annual supervisors' highway convention of State of New York (1904).
 Bulletin 7. Improvement, repair and maintenance of public highways (1904).
 Bulletin 8. Comparison of progress during period in which the State aid law has been in operation in New York State (1905).
 Bulletin 9. Proceedings of the sixth annual good roads convention of the board of supervisors of the State of New York (1905).
 Bulletin 10. Road Red Book (1905).
 Bulletin 11. Comparison of progress during the period in which the State aid law has been in operation in New York State (1906).
 Bulletin 12. Road Red Book (1906).
 Bulletins 13, 14, 15. Comparisons of progress during operation of State aid law (1907, 1908).
 Proceedings fourth to tenth semi-annual conference of State Highway Commission and County Superintendents of Highways.
 Location and drainage of highways. Extract from Bulletin 1.
 Erection of culverts and shortspan bridges (Directions for). Extract from Bulletin 1.
 State Library
 Legislature, Bulletins 16, 19-29, 31, 33, 35, and 36. 1902 to 1908.
 State Prison Commission
 Annual report, third, 1897. Employment of convict labor in building and improving highways.
 State Superintendent of Public Instruction
 Annual report, 1900. Good roads and good schools.
 State Agriculture Society
 Annual report, 1896. Good roads.
 Annual report, 1897. Necessity for State aid to roads. O. D. Dorner.
 State Museum
 Bulletin, vol. 4, no. 17. Road materials and road building in New York (1897).
 State Senate
 Document 26 (1896), vol. 5. Report of special committee on good roads.
 Document 27 (1903), vol. 6. Memorial regarding constitutional amendment to enable State to maintain commercial supremacy by development of main highways and issue of bonds to aid in their construction.
 Document 74 (1850), vol. 2. Report of secretary of State regarding number and length of plank roads of State.

[Approved by EDWIN DUFFY, State Highway Commissioner.]

NORTH CAROLINA

State Aid Legislation

In 1915, the legislature passed an act creating a State highway commission "to assist the counties in developing a State and county system of highways." It consists of the governor, three citizens from the eastern, middle and western parts of the State respectively, the State geologist, a professor of civil engineering of the University of North Carolina, and a professor of the North Carolina Agricultural and Mechanical College. They serve for

four years and their actual expenses are paid. The commission appoints a State highway engineer for a term of six years.

The road officials of any county may call on the State highway engineer for advice on any road and bridge problem, in which case he makes the necessary surveys, plans, specifications and estimates for them. If the work is carried out, it must be constructed according to these plans; if it is not carried out, the county must reimburse the State highway commission for its expense in furnishing the information. The State highway engineer must also "supply technical information regarding roads to any citizen or officer in the State." He must prepare plans, specifications and estimates for a system of roads connecting the county seats and principal cities and make traffic censuses. The commission is required to cooperate with county commissioners in educational work concerning the value of good roads.

Local Road Legislation

In some counties the roads are under boards of county commissioners, in other counties they are under the township authorities, but in most counties they are subject to special laws. Road taxes are worked out.

Local Bond Legislation

Upon presentation of a petition by not less than one-fourth of the qualified voters of any township to the board of county commissioners, the board shall within thirty days order an election in the town to determine if bonds shall be issued. This election shall be held subject to the rules and regulations of the general election laws of the State, and a majority vote of the qualified voters shall be necessary. Such elections shall not be held oftener than every twelve months. The amount of bonds that may be so issued shall not exceed \$50,000 for any one township in any county, and the bonds shall be paid by the township for which they are issued, and shall not be chargeable against any property or polls outside of the township. These bonds shall be coupon bonds, shall bear not to exceed 5 per cent interest, and shall be sold for not less than par value, and the interest and sinking fund charges shall be met by appropriate annual taxation. The fund raised by this taxation in excess of the amount required to pay interest shall be safely invested by the board of commissioners and the county commissioners are authorized to purchase any of these bonds to the amount of this excess annually, and after ten years they may purchase at a sum not exceeding par value, one-twenty-fifth of the bonds issued for any township.

Convict Labor Law

In counties having arrangements for working convicts upon public roads, the presiding judge shall sentence the following convicts to such work: All those convicted of crimes, the punishment of which is imprisonment in the county jail; those convicted of crimes the punishment of which is confinement in the State penitentiary not exceeding ten years; those sentenced to imprisonment in a county jail by a magistrate.

It is expected that over 2000 men will be available for road work in 1916.

Automobile Registration

The law provides for annual registration with the secretary of State. The schedule of fees is as follows: 25 h.p. or less, \$5; 26 to 40 h.p., \$7.50; 41 h.p. and over, \$10; motor cycles, \$2; manufacturers and dealers, \$10.

The registration revenue shall be paid into the State treasury and a separate account kept of it. On July 1, of each year, 80 per cent of such revenue shall be returned to the county from which collected for expenditure upon the public roads of such county and for no other purpose.

Progress Report

The commission assisted 45 counties in their road work and undertook the construction of three bridges in 1915.

Road Funds

The State appropriates \$10,000 a year for the State highway commission.

For the 1916 road fund it is estimated that about \$2,018,200 will be received from property and poll taxes, \$2,190,000 from bond issues, and \$98,730 from automobile and dog taxes and other sources, making a total of \$4,306,930.

Highway Officials

State Highway Commission.—Governor Locke Craig, Benehan Cameron, E. C. Duncan, Prof. T. F. Hickerson, Prof. Joseph Hyde Pratt, who also acts as secretary of the commission, Prof. W. C. Riddick and Guy V. Roberts. W. S. Fallis is State highway engineer. The commission's office is in Raleigh.

[Approved by W. S. FALLIS, State Highway Engineer.]

NORTH DAKOTA

State Aid Legislation

At the general election on November 3, 1914, an amendment to the constitution was adopted, providing that the State may grant aid in the construction and improvement of public highways.

The State law provides that inmates of the State penitentiary may be used upon the public highways. However, no convict labor has been used, for the reason that all of the convicts are needed to keep the regular industries of the penitentiary in operation.

The members of the State highway commission, consisting of the governor, the State engineer, and one other member to be appointed by the governor, serve without extra compensation. It is their duty to prepare plans and specifications and superintend the construction of any roads, when requested by any board having jurisdiction over such roads, and to give advice, assistance and supervision with regard to road construction throughout the State, as time and conditions permit, and as the rules and regulations of the commission may prescribe; to have prepared maps of the various counties showing the roads and location of bridges and culverts, and showing roads on which is proposed to utilize State funds whenever such funds may be available. They shall also issue bulletins containing advice and suggestions, and the law concerning highway construction, from time to time, as they shall deem practicable.

It is the duty of the State engineer, when requested by any board of county commissioners or township supervisors, to prepare plans for the construction of any bridges or culverts, or to examine and report on existing bridges or culverts, charging to the county or township for which such work is done, the actual and necessary expenses and the cost of the work.

Local Road Legislation

Under the North Dakota highway laws, in counties having no civil township organization the county board of commissioners act as a highway board; in organized townships the authority is vested in the board of supervisors. In localities where there is unorganized territory the county commissioners may create as many road districts as in their judgment is deemed expedient, and may appoint for each district an overseer of highways. At the first meeting of a township board, succeeding the annual town meeting, it shall appoint for one year a township overseer in direct charge of the construction and maintenance of highways. In unorganized territory the district overseer of highways shall have

the same powers and duties as township overseers of highways in organized townships. In counties having a county superintendent of highways the township road overseer shall be ex-officio deputy county superintendent of highways for his respective township. A law was passed in 1915 creating a board of highway improvements in each county, consisting of one member from each road district, which is required to formulate plans and methods for the uniform working and establishing of highways within the county. Such methods as they adopt must be followed in each of the districts in said county.

Local Bond Legislation

Section 183 of article 12 of the constitution authorizes counties, townships, cities, towns, or other political subdivisions to create an indebtedness not to exceed 5 per cent of the assessed valuation of the taxable property therein, but apparently there has been no general statutory enactment permitting the creation of an indebtedness for road purposes under authority thus conferred.

Convict Labor Laws

The board of control is authorized to employ upon the public highways, under the supervision of proper guards, all the convicts not needed in the State twine plant and other established penitentiary industries. They may also be employed by the several counties of the State for work on the public roads thereof when it is mutually so agreed by the county commissioners and the State board of control, the county paying all the salaries and expenses in connection with said work. The convicts shall at all times be under State control, and shall be supervised by skilled laborers who shall at the same time act as guards. As nearly as practicable, all the men shall be pledged on their word of honor not to attempt to escape, they shall be dressed uniformly, and shall bear some insignia not too conspicuous, and shall not be required to work more than ten hours in any one day. Also, a convict shall not be assigned to work in the community from which he came.

The convicts are entitled to a credit of from 10 to 25 cents per day, the exact amount depending upon the amount and manner of work done, and in addition thereto, those assigned to outside work are entitled to a double allowance of "good time."

Automobile Registration

The law provides for annual registration with the secretary of State. The registration fee for all motor vehicles is \$3.

The net registration revenue is returned to the county from which collected for expenditure for repairs and maintenance of the main traveled roads of the county, provided that no part of said funds shall be expended within the limits of an incorporated town or city, nor within any township that does not levy a road tax of at least 6 mills on the dollar of assessed valuation. (Chapter No. 6, Laws, 1911.)

Progress Report

During 1915 the State engineer issued standard specifications to a number of counties, and engineering services were performed for several counties. Plans and specifications were also prepared for a \$20,000 bridge undertaken mainly by private subscription. It is estimated that during 1916 over \$2,700,000 will be spent for roads and bridges.

Road Funds

In addition to funds secured by automobile and motor cycle licenses, the highway maintenance funds are secured by means of a poll tax of \$1.50 and a property tax of not to exceed 4 mills on the dollar for bridges and not to exceed 5 mills for highways. In each county having a population of 2000 or more, according to the latest United States or State census, there is levied a property tax of not less than 0.25 mill nor more than 4 mills, which is kept in a distinct fund known as the county road fund and is spent in highway improvement under the direction of the county commissioners. This fund is in addition to all other taxes for highway purposes and is expended only in grading, ditching and surfacing the principal county thoroughfares for which the means otherwise provided are not, in the opinion of the county commissioners, sufficient.

The electors of each township have power at their annual meeting to vote to raise such sums of money for the repair and construction of roads and bridges as they shall deem expedient, provided, that the amount of tax for road purposes shall not exceed 8 mills on the dollar, and the tax for bridge purposes shall not exceed 2 mills on the dollar.

Highway Officials

State Engineer.—Jay W. Bliss, Bismarck.

Highway Commission.—Gov. L. B. Hann, Bismarck; C. A. Grow, Minot; Jay W. Bliss, Bismarck.

[Approved by JAY W. BLISS, State Highway Engineer.]

OHIO

State Aid Legislation

There is a State highway department to afford instruction, assistance and coöperation in the construction, improvement and maintenance and repair of the public roads and bridges of the State. It is under a State highway commissioner, appointed by the governor for four years, who appoints three deputy highway commissioners, all required to be civil engineers and one of them designated by him as chief highway engineer. One deputy has charge of road construction, another of road maintenance and repair, and the third of bridges and culverts. The State highway commissioner also appoints as many division engineers, superintendents, inspectors, clerks and other assistants as the work requires.

The State highway commissioner supervises the construction, improvement, maintenance and repair of inter-county highways and main market roads, including their bridges and culverts. Seventy-five per cent of the State highway improvement fund is spent on inter-county highways, and is equally divided between the counties; 25 per cent is spent on main market roads and must be spent so as to distribute equitably the benefits from such expenditure to the different counties. The inter-county highways have been designated by statute and by the State highway commissioner; the main market roads form part of these highways and were similarly designated.

The State highway commissioner advises county commissioners on road construction and maintenance. Plans for bridges costing over \$10,000 on county and township roads must be approved by him, and he prepares plans for constructing and repairing any highway bridge when requested by local authorities. Tests and investigations of road and bridge materials are made for him by the Ohio State University. He is responsible for the maintenance and repair of all roads and bridges built with State aid or taken over after construction.

Local Road Legislation

The improvement of roads in a township is under its board of trustees, but the plans and specifications must be provided by the county highway superintendent, who is also the county surveyor, and the work must be done under his supervision and all payments for it must have his approval. Each township has one to four road districts, with a township highway superintendent in each, appointed by the trustees; he has control of township roads under the direction of the trustees, but also reports annually to the county highway superintendent and must comply

with all regulations of the latter not in conflict with instructions from the trustees.

The location, alteration and vacation of all roads in a county, except inter-county and main market roads, are under the county commissioners. The latter also have power, when petitioned by over half of the owners of property taxed for the improvement, to construct, reconstruct, repair or maintain new or existing roads; they can also undertake such work without petition by unanimous vote. Plans and specifications must be prepared for such work by the county surveyor.

A county road improvement may be extended through a municipality with the consent of its council, if the municipality will pay a part of the cost.

The county highway superintendent has general charge, subject to the regulations of the State highway department, of the construction, improvement, maintenance and repair of all bridges and State, county and township highways in the county. He may be removed by the State highway commissioner for incompetence or neglect, and may call on the State highway commissioner for advice and assistance.

When 40 per cent of all roads in a county have been improved with gravel, broken stone, slag, brick, cement or bituminous materials to a standard approved by the State highway commissioner and the county commissioners make an appropriation for constructing or improving inter-county roads, they may apply to the State highway commissioner for State aid. This is then furnished to an equal amount by the State highway commissioner from the county's apportionment of any road funds in the State treasury, but must be spent in accordance with plans approved by the State highway commissioner. The work is advertised and let by the State highway commissioner. The local contribution of 50 per cent of the cost of roads thus built is subdivided into 25 per cent from the county, 15 per cent from townships and 10 per cent from special assessments. When the local contribution exceeds the county's apportionment of State aid funds, the distribution of costs is adjusted by mutual agreement.

No load exceeding 3400 pounds, inclusive of the weight of the vehicle, shall be carried by a vehicle. Anybody driving on an improved road a traction engine with tires equipped with lugs, spikes or other projections seriously destructive to the highway, shall be fined not less than \$10 or more than \$200 for each offense.

Local Bond Legislation

If the township road tax is inadequate to meet expenses for road construction and repair, bonds to supply the funds lacking

may be authorized by a majority vote of the electors of the township. The bonds may not bear over 6 per cent interest or run longer than 10 years, and may be issued in denominations of \$100 to \$1000. The payment of principal and interest is met by taxation in addition to the general township tax, subject to the limitation on the combined maximum rate for all taxes.

Townships may issue 5 per cent 10-year bonds in anticipation of taxes to pay for quarries, gravel pits and equipment for working them.

County road bonds running not more than 10 years and bearing not more than 5 per cent interest may be issued by the county commissioners in anticipation of taxes and assessments, but they cannot be sold for less than par. The proceeds are restricted for use on the improvement for which they are issued. Five per cent county road bonds running five years may be issued in anticipation of taxes and assessments to meet the local share of roads built with State aid, but the total issue must not exceed 1 per cent of the county's tax duplicate.

Convict Labor Laws

State convicts may be used on State aid roads or in preparing materials for the roads. The prison authorities prepare the regulations for the government of the convicts, but the work and the manner of doing it are under the control of the State highway commissioner. The latter pays the transportation, maintenance and guarding expenses plus an amount to each prisoner's credit for his work. County commissioners may also employ State convicts on the same terms, and may also employ prisoners in county jails and workhouses, at a rate agreed upon between the commissioners and the prison authorities. Convicts and prisoners may also be used on contract work.

Road Funds

The board of trustees of a town may levy a tax not exceeding 3 mills annually for improving, maintaining or repairing roads. A 2-mill tax may also be levied for township contributions to the cost of roads built with State aid. A township tax may be levied for acquiring quarries and gravel banks.

County road expenses are met in eight ways. 1. From 35 to 50 per cent of the cost of an improvement may be taken from proceeds of general county taxes; from 25 to 40 per cent from the proceeds of county road taxes, and the balance raised by special assessment on a two-mile strip of land. 2. From one-half to two-thirds of the cost may be taken from the proceeds of county

road taxes and the balance raised by special assessment on a two-mile strip. 3. Any part of the cost may be raised by special assessment on abutting property, the balance to be paid by the county and townships. 4. Any part may be raised by special assessment on a two-mile strip and the balance paid from county funds. 5. The entire cost may be met by special assessment on a two-mile strip of land. 6. The entire cost may be raised by special assessment on a four-mile strip. 7. Not over half the cost may be paid out of the proceeds of the county road taxes and the balance raised by assessment on a one-mile strip. 8. The entire cost may be met by special assessments on a two-mile or four-mile strip, as the petitioners request; or not over half the cost may be raised by special assessment on a one-mile strip and the remainder may be taken from the proceeds of county road taxes. By unanimous vote the county commissioners may pay the entire cost of an improvement from county road funds, or may agree with the authorities of townships in which the improvement is made for a division of the expenses. The county road tax must not exceed 2 mills and the total taxation must not exceed the limitation on the combined maximum rate for all taxes. The county may also levy a tax not exceeding 3 mills on the property in each township in which a county road improvement is made, for the purpose of meeting the township's share of the cost. The county may also levy a 1-mill tax for its contribution to roads built with State aid.

One-half the funds from automobile registration are used for maintaining the inter-county highways and one-half for maintaining the main market roads.

An annual tax of 0.3 mill is levied to furnish the State highway improvement fund and is outside the limitation upon maximum combined taxes.

Automobile Registration

Automobiles are registered with the secretary of State, the annual fees being: motor cycles, \$2; electric vehicle, \$3; gasoline or steam vehicle, \$5.

Highway Officials

State highway commissioner, Clinton Cowen; deputy commissioner in charge of construction, H. M. Sharp; deputy commissioner in charge of bridges, John R. Chamberlin; deputy commissioner in charge of maintenance, A. H. Hinkle; chief clerk, H. L. Hastings; secretary, M. L. Freeman.

*Publications***State Highway Department**

Annual reports from 1905 to 1915.

- Bulletin 1. Preliminary instructions and forms. Sam Houston.
- Bulletin 2. Construction of country roads. Sam Houston.
- Bulletin 3. Maintenance of country roads. Sam Houston.
- Bulletin 4. State supervision and State aid. Sam Houston.
- Bulletin 5. Convict labor for road improvement. Sam Houston.
- Bulletin 6. Condition and cost of country roads in Ohio.
- Bulletin 7. Revised instructions and forms. Sam Houston.
- Bulletin 8. Road laws of Ohio (exhausted).
- Bulletin 9. Proposed amended State aid law. Sam Houston.
- Bulletin 10. Road laws of Ohio. Exhausted.
- Bulletin 11. Highway maps of the counties of Ohio (exhausted).
- Bulletin 12. Report of experiments to determine the comparative value of various road binding materials.
- Bulletin 13. Supplemental report of Nelson Avenue experimental road and report of experiments in binding gravel and crushed gravel with tar and asphalt, and also in constructing a waterbound road of gravel.
- Bulletin 14. An act creating a State highway department and providing aid in construction and maintenance of highways (supply exhausted but a revised copy in hands of printer).
- Bulletin 15. Supplemental report No. 2 on Nelson Avenue experimental road and supplemental report No. 1 on experimental road in Darke County.
- Bulletin 16. The effect of wagon roads.
- Bulletin 17. Earth roads.
- Bulletin 18. A review of the work of the State highway department.
- Bulletin 19. South High Street experimental road (preliminary issue).
- Bulletin 20. Instructions for dragging roads and road dragging laws.
- Bulletin 21. Legislation pertaining to the construction, improvement, maintenance and repair of roads and bridges by the State highway department and an act providing for a levy and designating the main market roads.
- Bulletin 22. Highway compendium.
- Bulletin 23. Names and numbers of inter-county highways.
- Bulletin 24. General specifications for materials (exhausted).
- Bulletin 25. General specifications for materials (revised).
- Bulletin 26. How to get State aid.
- Bulletin 27. Dust prevention.

OKLAHOMA*State Aid Legislation*

The State department of highways is under the charge of the State commissioner of highways. He is required to furnish without charge to any road official standard plans and specifications for roads and bridges, to report on plans and specifications submitted by any road official, to compile statistics of the roads in the State, to establish in each county standards for the construction and maintenance of its roads and bridges, and to advise with State and municipal authorities on water and sewerage projects. With

the consent of the governor he appoints a State engineer and an assistant State engineer.

The State aid roads are designated originally by the county officials, and the State and counties contribute equally toward their cost.

Local Road Legislation

The board of county commissioners of each county must appoint a county engineer, who must pass an examination held by the State department of highways or be a civil engineering graduate from some reputable school. One person may serve as county engineer for two or more counties. The board of county commissioners selects from 10 to 15 per cent of the total mileage of roads connecting principal market points in the county and joining similar roads in adjacent counties, to serve as State roads. This system of State roads is examined by the commissioner of highways, and only such portions as are approved by him are adopted as State roads. If any county fails to designate such a road system, the commissioner of highways has power to do so. The surveys and plans for these roads are prepared by the county engineer. All bridges and culverts must be permanent and approved by the department of highways.

Other roads are under the township officials. When the State roads of a county are finished, township roads of an equal standard of construction may be added to the State system. The road work of each township is under a road superintendent, but the plans and specifications must be furnished by the county engineer.

After January 1, 1917, no draft wagon of 1 ton capacity or more, having metal tires less than 3 inches wide, may be sold in the State under penalty of a fine of \$25 to \$100 for each sale.

All male residents are required to work on roads or pay \$3 commutation to the local road authorities.

Local Bond Legislation

The township board may issue bonds in an amount not exceeding 3 per cent of the taxable property upon a three-fifths vote at a special election. The bond interest shall not exceed 6 per cent, and the term shall not exceed twenty-five years. An annual tax shall be levied to pay the interest and to create a sinking fund for the redemption of the bonds at their maturity.

The county commissioners of any county are authorized, upon a three-fifths vote of those voting at a special election, to issue county bonds for building, repairing or acquiring bridges, and the term of the bonds shall not exceed twenty-five years and their interest shall not exceed 5 per cent. An annual tax is levied to meet the interest and sinking fund charges on the bonds.

Road improvement districts of not less than 8 square miles in area may be created in any county upon written petition signed by 15 per cent of the qualified electors of the proposed district, filed with the county clerk. Such petition shall ask for a vote on the bond issue for the improvement of the roads in the district, and at the election a three-fifths majority of those voting shall be required to authorize the issuance of bonds. Interest on these bonds shall not exceed 5 per cent, and the term shall not exceed twenty-five years. The board of county commissioners shall annually levy upon all the taxable property in the road improvement district a tax sufficient to pay the interest on the bonds and to create a sinking fund for their redemption.

Convict Labor Laws

State convicts are required to be worked on public highways as continuously as possible. The State board of public affairs furnishes tools, machinery and draft animals; the cost of quarters, food, medical attendance and guards is borne by the prison funds; a county using convict labor pays all charges for transportation, feed for animals, board for guards, supplies for machinery, and materials for construction. The State board of public affairs formulates the regulations for governing the convicts and the State corporation commission establishes the transportation rates for the convicts. The last legislature failed to appropriate funds for equipment.

Automobile Registration

Motor vehicles are registered with the department of highways. The fee is 50 cents per horse power, A. L. A. M. rating for the first year, 40 cents the second year, 30 cents the third year, and 20 cents a year afterward; dealers' fee, \$15. Nine-tenths of the fees are returned to the counties where payment of them was made. The treasurer of each county pays 25 per cent of this money to first-class or chartered cities and the remainder is used as a county road maintenance fund for road dragging and construction of new roads. During 1915, the fees amounted to \$154,198, including fees for traction engines, but omitting electric vehicles which were not registered on account of a flaw in the law.

Highway Officials

Commissioner of Highways.—George B. Noble; acting State engineer, W. P. Danford; assistant State engineer, C. G. Adkins; consulting engineer, Prof. J. I. Tucker. Offices at Oklahoma City.

Progress Reports

Plans for 250 bridges costing \$425,000 and 50 culverts costing \$20,000 have been approved, and about 50 plans for bridges and culverts have been rejected. Of the 77 counties 71 have designated their State roads, with a total length of 12,604 miles, of which 1370 miles have been improved. In 46 counties 1370 miles of State roads have been surveyed and plans and profiles prepared for their improvement. Most of the improvement is confined to drainage, grading and bridge and culvert building, and only 21 miles of concrete, macadam or gravel roads are reported. The inauguration of the work has involved the purchase of equipment, surveys, plans and other preliminaries, and it is expected that the construction in 1916 will proceed at a much more rapid rate. The average cost of surveys and plans has been \$10.05 a mile. The State department of highways has been unable, on account of inadequate funds, to give the assistance which county commissioners have requested under the law.

Road Funds

The State collects a property tax of 0.25 mill, the proceeds forming the State highway construction fund, but used by the counties for State roads. Each county may levy a property tax of 0.25 mill for use on roads under the board of county commissioners; any county levying this tax is entitled to receive the money in the State highway construction fund standing to its credit. The townships are authorized to levy a 2-mill tax for road dragging and not over 1½ mills for construction. The quarter-mill tax for State roads has proved inadequate and private subscriptions have been made to enable the work to proceed.

The State appropriation for the department for the year ending July 1, 1916, was \$12,600; this proved inadequate on account of the expense of automobile registration and the governor allowed payments to meet unavoidable deficiencies and the use of clerical assistance from other departments.

*Publications***State Agricultural Experiment Station**

Bulletin 21. Road making and repairing. 1896.

State Geological Survey

Bulletin 2. Preliminary report on rock asphalt, asphaltic petroleum, and natural gas in Oklahoma. 1911.

Bulletin 7. Preliminary report on the clays and clay industries of Oklahoma. 1911.

Bulletin 8. Preliminary report on the road materials and road conditions of Oklahoma. L. C. Snider. 1911.

State Department of Highways
Bulletin 1. Concrete culverts and bridges.
Bulletin 2. Metal culverts.
Biennial report, 1911, 1912.

[Approved by GEORGE B. NOBLE, Commissioner of Highways.]

OREGON

State Aid Legislation

There is a State highway commission which consists of the governor, secretary of State, and State treasurer.

The duties of the commission are to determine a system of State roads and to construct the same as money becomes available for that purpose. The State engineer is required to act in an advisory capacity to the county courts of the different counties in the matter of road construction and maintenance, whenever so requested. On request of the county court of any county, the State engineer must furnish plans and specifications for any piece of proposed road construction, or any bridge, free of all cost to such county. Prior to 1915, there was a State highway engineer, but the office was abolished and the work transferred to the chief deputy State engineer, who reports to the State engineer.

Local Road Legislation

Jurisdiction over roads vests in a county or commissioner's court, and the chairman of the court is county judge. The State has authority to construct and maintain, or assist in construction or maintenance, but no authority to establish a road.

Road Bond Legislation

A proposition to issue county road bonds may originate in either of four ways: First, upon the petition of the registered voters equal to one-fourth of the greatest number of votes cast for any candidate for judge of the supreme court at the last general election in that county, or by 5000 registered voters, the county court *shall* submit a proposition to issue county road bonds at a special election called for that purpose; second, upon the petition of one-twentieth of the registered voters, as above, the proposition *may* be submitted at a special election; third, upon the petition of one-tenth of the registered voters, as above, the proposition *shall* be submitted at the next general election; and fourth, the county court *may* submit the proposition at any general election of its own motion.

Upon a favorable vote of the majority of all those voting at the special or general election, the county court shall issue the road bonds or the county warrants in lieu thereof, as funds are needed. The bonds shall be issued in denominations of not less than \$50 nor greater than \$1000, and shall bear interest not to exceed 6 per cent. The aggregate of all bonds outstanding shall not exceed 2 per cent of the assessed valuation, and shall be sold to the highest bidder. The proceeds shall be expended only in constructing permanent public roads as specified in the order submitting the proposition. A special tax may be levied to pay interest charges, and to provide a sinking fund for the payment of the principal, or provision therefor may be made by transferring funds to such sinking fund.

Convict Labor Laws

State.—The State highway commission may authorize and provide for the construction of any State road or part of such road by convict labor; and if said commission so authorizes and provides convict labor, the governor shall, upon its request detail from the penitentiary such convicts as in his judgement may seem proper for use in the work of constructing said road or part of a road; and such convicts shall be delivered to said engineer on such terms and conditions as shall be prescribed by the parole board and approved by the governor.

County.—Upon the written request of the county court of any county, the governor may detail from the State penitentiary such convicts as in his judgment may seem proper for use on the public highways. Said convicts shall be delivered to any county court on such terms and conditions as shall be prescribed by the parole board and approved by the governor.

Automobile Registration

The law provides for annual registration with the secretary of State. The schedule of fees is as follows: 26 h.p. and less, \$3; 27 to 36 h.p., \$5; 37 to 40 h.p., \$7.50; over 40 h.p., \$10; electric pleasure vehicles, \$3; electric commercial vehicles, \$5; motor cycles, \$3.

The net balance of registration revenues on December 31 of each year is returned to the county treasurer of the county from which collected to be credited to the general road fund. Fines and forfeitures are also paid to the county treasury to be credited to the general road fund.

Highway Officials

State engineer, John H. Lewis; chief deputy State engineer, E. I. Cantine.

Progress Report

During 1915 the State work was mainly on roads started in 1914 and surveys for the Pacific Highway in Douglas County and the Columbia River Highway in Wasco County. The State and county funds spent under the direction of the State highway commission amounted to \$646,000. There are about 37,600 miles of public roads of which 964 miles were surfaced with broken stone, 25 miles with hard surfacing, 3745 miles with gravel and 232 miles with plank, at the close of 1914.

Road Funds

There was \$230,000 of State funds available for road work at the opening of 1916.

Publications

State Highway Engineer

First and Second Annual Reports. 1914-1915.

State Agricultural College. Department of Geology and Mining Engineering.

Bulletin 1. Road materials in the Willamette Valley. H. M. Parks. 1911.

Bulletin 2. Highway improvement—earth roads and culverts. E. F. Ayers.

State University

Bulletin, vol. 10, no. 5, Concrete Roads vs. Macadam, E. H. McAllister.

[Approved by E. I. CANTINA, Chief Deputy State Engineer.]

PENNSYLVANIA*State Aid Legislation*

The act approved May 31, 1911, and its supplements, provided for the appointment of a State highway commissioner, two deputy State highway commissioners (one of whom must be a competent civil engineer), an auditor, and a chief engineer. These appointments are made by the governor of the Commonwealth by and with the consent of the senate. The State highway commissioner appoints an engineer of bridges; 50 superintendents of highways; and 15 civil engineers, together with a chief clerk, chief draftsman, assistant draftsmen, and a force of clerks and stenographers.

The State highway commissioner was directed to make a survey of all roads of the State and a general highway plan of the State. He collects statistics, publishes maps giving a complete road survey of each county, and may be consulted by county, city, borough, and township officials. He is directed to construct, improve, and thereafter maintain at the expense of the

Commonwealth the highways forming the system of State highways, the specifications for which are to be prepared by the State highway department.

The State highway system, which comprises approximately 10,200 miles, is under the exclusive jurisdiction of the State highway department, and comprises the main traveled routes between county seats and principal cities, boroughs and towns, and the main traveled routes leading to the State line. In 1913 a bill was passed creating additional State highways, to become effective June 1, 1915, and another bill making changes in the existing State highways, which became effective the date of approval, July 22, 1913.

Where the expense of constructing a route may be materially lessened by a change of location from that at present defined, the State highway commissioner may, with the approval of the governor, change the location of such a route.

Where a toll-road company controls any part of a route forming a State highway, the State highway commissioner may purchase the toll road at a fair and reasonable price, to be approved by the governor.

State aid is granted for improving State and other highways. Counties, townships, or boroughs (as the case may be), which desire State aid can proceed in the following manner: The township supervisors or commissioners or borough council of the township or borough in which the road lies shall first make petition to the county commissioners, and it shall then be the duty of the county commissioners to adopt a resolution assuming on behalf of the county its share of the cost of the proposed improvement. The county commissioners shall then petition the State highway department for State aid, the cost of the improvement to be prorated among the townships or boroughs (as the case may be), the county, and the State, the State paying 50 per cent of the cost of reconstruction, the county and township, or borough (as the case may be), the other 50 per cent. If either the county, township, or borough desires to act independently of the others, it makes application direct to the State highway department and agrees to assume 50 per cent of the total cost, in which event the other 50 per cent is paid by the State. The State also pays 50 per cent of the cost of maintenance, the other 50 per cent being paid by the township or borough in which the road may lie.

The State aid fund is apportioned among the several counties of the State according to the mileage of township and county roads.

By action of the 1913 legislature, the creation within the State highway department of a bureau of township highways was made mandatory, and the State highway commissioner made responsible

for the supervision of all the township highways and bridges constructed and improved, maintained in whole or part by the aid of State moneys; requiring him to prescribe rules and regulations fixing the duties of township officers in respect to all highways and bridges under his jurisdiction; to compile statistics relating to such highways throughout the State; collect traffic census and such other information in regard thereto as he should deem expedient; and call meetings or conventions of township supervisors at such times and places as he deems wise. In addition the State Highway commissioner is responsible for the distribution of bonus funds to townships which are on a cash tax basis; such distribution to equal 50 per cent of the amount of cash tax collected when such 50 per cent would not exceed \$20 per mile, this distribution being provisional upon the township treasurer filing a certified copy of bond given by him and an agreement executed covering the proposed expenditure of State money to be received.

In 1913, a maintenance department was established under the direct charge of a maintenance engineer, with a view of standardizing and systematizing of all maintenance work under the jurisdiction of the highway department. This division is now so systematized that the operation of each unit of the maintenance force in the field is reflected in this department immediately upon the expenditure of any money, and each dollar expended is so recorded that the department can locate, by referring to station numbers reported, the 100 feet upon which expended and for what used.

Local Road Legislation

Jurisdiction over local roads vests in boards of county commissioners, and in three supervisors of roads, one elected every other year, in each township and borough. The property road tax is partly rebated to persons complying with the wide-tire ordinance.

Local Bond Legislation

The county commissioners of the several counties may borrow money for improving and maintaining the public roads, and may issue bonds for these improvements. The amount shall not exceed in the aggregate 2 per cent of the total of the assessed valuation of all property in the county at the last triennial valuation; but, no such bonds or indebtedness shall bear interest exceeding 5 per cent. The county commissioners shall not issue bonds in one year to exceed one-half of 1 per cent of the total valuation of all property, as shown at the last triennial assessment; provided, that the amount of bonds issued in any one year in excess of one-tenth of 1 per cent of such total valuation of all property shall be approved by the grand jury and court of quarter sessions.

Convict Labor Law

All male persons sentenced to county jails and workhouses may be assigned to work on public roads of the county by the prison board. Preference shall be given to the making of new roads and the repair of main roads, all roads to conform to the plans and specifications of the State highway commission. The work shall be done in 5 mile sections by townships in rotation. No convict labor was used in 1915.

Automobile Registration

The law provides for annual registration with the State highway department. The schedule of fees is as follows: Less than 20 h.p., \$5; 20 to 34 h.p. \$10; 35 to 49 h.p., \$15; 50 h.p. and over, \$20; motor cycles, \$3. Motor vehicles with solid tires, less than 4,000 pounds gross, \$5; 4,000 pounds and less than 5,000 pounds gross, \$10; 5000 pounds and less than 10,000 pounds gross, \$15; 10,000 pounds and less than 15,000 pounds gross, \$20; 15,000 pounds and not over 24,000 pounds gross, \$25; not licensed over 24,000 pounds. Chauffeur's license, \$2; dealers and manufacturers for each pair of number tags, \$10.

Registration revenue is paid into the State treasury forming part of the appropriation for the construction, maintenance, improvement and repair of State highways and State-aid highways. Fines and forfeitures imposed for violation of the provisions as to speed and weight shall be paid into the treasury of the city, borough, town or townships in which such violations occur for expenditure in construction, maintenance and repair of the highways thereof. Other fines and forfeitures are paid into the State treasury for use in the same manner as registration revenues. Prior to June 1, 1915, the registration fees were used in addition to instead of as part of the State appropriation.

Highway Officials

State Highway Department, Harrisburg.—R. J. Cunningham, State highway commissioner; J. W. Hunter, first deputy commissioner; G. H. Biles, second deputy commissioner; W. D. Uhler, chief engineer; W. R. Main, C.P.A., auditor; Howard W. Fry, chief clerk; W. R. D. Hall, statistician.

Progress Report

This State has a total of 97,850 miles of roads.

There are approximately 2000 miles of State highway routes and State-aid roads, constructed wholly by the State highway department of Pennsylvania in good condition. In addition there are sections of highways constructed by counties and townships

independent of the State, information regarding which is not available. There are 416 miles of improved toll roads on State highway routes.

Mileage completed at total expense of State is 931 miles on December 31, 1915.

Mileage uncompleted under contract at total expense of State on December 31, 1915, is 5.94.

Mileage of State-aid highways built under the provisions of acts since June 1, 1911, is 163.89 miles, and 905.1 miles of State-aid highways were built under the provisions of acts previous to June 1, 1911, making a total of 1068.99 miles completed.

Mileage of State-aid contracts not completed December 31, 1915, is 6.54 miles.

Total miles now being maintained at total expense of State is 10,200.

Of the 1068.99 miles of improved roads built by State aid, about 358.83 miles are not on State highways, and are maintained by the State and township or borough, each bearing 50 per cent of the expense. The remaining 715.16 miles of State-aid highways are on State highway routes and maintained at total expense of the State. A small percentage of the above is constructed of brick and asphaltic concrete.

Contracts let during 1915:

	<i>Miles</i>
Telford macadam	1.04
Brick block	0.83
Asphaltic macadam	6.63
Asphaltic concrete	3.73
Total	11.73

Practically all highways are 16 feet wide. Some borough work is wider.

A uniform system of accounts devised by this department likewise has been installed throughout the State, and all necessary books, blanks and forms have been furnished the various township officers.

The first deputy State highway commissioner has direct charge of this bureau.

During 1915, the maintenance division maintained 556.89 miles of gravel, flint and shale roads and 6091.15 miles of earth roads. The forces of this division also resurfaced 525 miles of State highways and State-aid highways in 1915 and treated with various grades of asphaltic and dust-laying oils 1084.22 miles.

Road Funds

The legislature of 1915 appropriated \$8,300,000 for the State highway department, divided as follows: For the maintenance

and repair of State highways, \$6,000,000; for expenses, costs and awards in acquiring turnpikes forming parts of State highway routes, \$250,000; for the commonwealth's share in the expense of constructing and maintaining State-aid highways, \$500,000; for the rebuilding, repair and maintenance of the National, or Cumberland, road, in Somerset, Fayette and Washington Counties, \$50,000; for the payment of a portion of the deficiency caused in 1913 and 1914 in carrying out the laws of the State relative to the construction, maintenance and repair of roads in second class townships, \$1,500,000. These appropriations are for the period from June 1, 1915 to June 1, 1917.

An important proviso was included in this appropriation bill which reads as follows: "Provided, That the appropriations made by this Act shall include and not be in addition to the amounts received by the Commonwealth during the two fiscal years beginning June 1, 1915, for the licensing of motor vehicles and drivers, under the Act of July 7, 1913."

The total amount of road taxes collected in cash by second class townships during the year 1914, was \$5,532,742.33 and the amount to which they are entitled, viz.: 50 per cent when not exceeding \$20 per mile was \$1,422,570.52. The total amount distributed during 1915, viz.: \$796,598.84 represents a pro rata distribution of 30 per cent of the balance due them for the years 1913 and 1914.

Appropriation balances and cash expenditures from January 1, 1915 to January 1, 1916

Balance in State treasury, January 1, 1915 (available for use of State highway department). \$545,014.39

Receipts during year 1915

New appropriations, Act 1915.....	\$7,661,000.00
Deficiency appropriations, Act 1915.....	49,000.00
Automobile license receipts, year 1915 (to June 1, 1915).....	1,420,433.00
Automobile old balance.....	187,771.42
State aid fund reimbursement.....	726,049.93
State highway fund reimbursement (Westmoreland County).....	19,121.07
Refund, account advances from 1914 funds, etc.....	24,775.11
Total receipts, 1915.....	\$10,088,150.53

Less:

Balances, 1913 appropriations, returned State Treasurer.....	43,938.34	\$10,044,212.19
Total funds available for period from January 1, 1915 to June 1, 1917.....		\$10,589,226.58

Cash expenditures, January 1, 1915 to January 1, 1916

Payments on contracts.....	\$999,409.97	
Engineering, inspection and advertising, contracts and applications.....	45,388.89	
Surveying and plotting State highway routes.....	90,846.11	
Surveying and plotting county maps.....	15,246.13	
Refund to Allegheny County.....	244.94	
Damages on account of change of line.....	262.50	
Maintenance and resurfacing:		
State highway routes..	\$3,664,228.00	
State aid roads.....	356,920.51	4,021,148.51
Machinery, tools and equipment.....	68,810.94	
Toll roads purchased.....	66,496.28	
Experimental work and cost of testing lab- oratory.....	22,659.67	
Operating expense—Department and Divi- sion Offices.....	91,378.67	
Traveling expense.....	72,157.74	
Contingent expense.....	51,676.74	
Department salaries.....	177,910.39	
Bureau of Township roads.....	21,020.70	
Cost of tags and operating expense, Auto License Division.....	114,577.89	
Total department expenditures, year 1915.....		\$5,859,236.07
Balance, available funds, January 1, 1916.....		\$4,729,990.51

In addition to the above expenditures, funds in amount \$796,-
598.84 were distributed to townships as cash tax bonus.

*Publications***State Highway Department**

Annual reports from 1904.

Instructions to employes in the construction and maintenance of highways.

Pennsylvania Highway News

- Bulletin 1. Supervisors and their duties.
- Bulletin 2. Standards.
- Bulletin 3. Road drainage.
- Bulletin 4. Bridge construction and maintenance.
- Bulletin 5. Earth road location and construction.
- Bulletin 6. Earth road maintenance.
- Bulletin 7. Supervisors' duties.
- Bulletin 8. Work and purpose of bureau of township highways.
- Bulletin 9. Specifications for culverts and short span concrete bridges.
- Bulletin 10. Specifications for steel highway bridges.
- Bulletin 11. Road laws and instructions.

State Department of Agriculture

- Bulletin 15. Good roads for Pennsylvania, 1896.
- Bulletin 66. Pennsylvania road statistics by townships. John Hamilton.
- Bulletin 69. The road making materials of Pennsylvania. M. C. Ihlsing.
- Bulletin 121. Address of Hon. J. W. Hunter, State highway commissioner.

[Approved, W. R. D. HALL,
Statistician, State Highway Department.]

PHILIPPINE ISLANDS

The governor-general is the administrative head of the insular government. He is ex-officio president of the Philippine commission, which exercises exclusive jurisdiction over territory inhabited by Moros and other non-Christian tribes and forms the upper chamber of the Philippine legislature. The majority of the commission are Filipinos. The secretary of commerce and police, a member of the commission, is in general charge of roads, outside the non-Christian provinces, and the detailed charge is in the hands of the bureau of public works, except for work in Manila and in municipalities which do not request the bureau to take charge. The roads in the non-Christian provinces are under the governor of the department of Mindanao and Sulu, but in direct charge of a supervising engineer of the bureau of public works. The bureau's work is distributed through 39 districts, each under a district engineer, of whom about one-fourth are Filipinos.

Progress

At the close of 1914 there were 2564 kilometers of first-class roads with heavy surfacing in the islands, 2024.3 kilometers of second-class roads with light surfacing, 2875.7 kilometers of third-class or graded and drained roads, and 915.8 kilometers of trails. In addition there were 25.6 kilometers of second-class roads, 184 kilometers of third-class roads and 1258 kilometers of trails in the department of Mindanao and Sulu.

An attempt is being made to utilize Filipino engineers as rapidly as possible, as a measure of economy, explained in the 1914 report of the secretary of commerce and police as follows: "As most of the employes, other than Filipinos, come from the United States, it is obligatory on the Philippines, economically a poor and undeveloped country, to pay salaries on the United States scale, which is the highest in the world. This is an artificial scale for the Philippines and only adopted because of necessity. It would be an economic crime to apply this very high scale to the remuneration of Filipino engineers or other Filipino employes. They should receive salaries proportionate to the economic conditions of the Philippines."

The most serious single maintenance charge has been for the maintenance of the Benguet road leading to Baguio, the health resort of the islands. That road is 45 kilometers long and cost 3,932,694 pesos, or about \$69,800 per mile. It lies in part in a canyon where a rainfall of 46 inches in 24 hours has been recorded and the annual cost of maintenance has been as high as 358,686 pesos. In order to avoid such charges a new road was completed

to Baguio in 1915, known as the Naguilian road, 50 kilometers long. It lies mainly on ridges, where it is less exposed to damage by storm-water than a road located on mountain sides, and cost about 631,000 pesos exclusive of bridges. With the latter, the cost will be about \$16,300 per mile.

Road Funds

During 1914, 9,894,293 pesos were spent by the bureau of public works, of which 5,434,596 pesos were from insular sources and the remainder from provinces and municipalities. Of this total, 5,652,437 pesos were spent for the construction and maintenance of roads. In addition 66,752 pesos were spent for the maintenance of roads and trails in five of the seven provinces of the department of Mindanao and Sulu. The bureau operates several auto bus lines, some at a profit.

Highway Officials

Director of public works, Warwick Greene; acting director of public works, E. J. Westerhouse; consulting architect, G. C. Fenhagen; chief designing engineer, C. E. Gordon; senior supervising engineer, Mindanao and Sulu, H. F. Cameron. Main offices, Manila.

Publications

Annual reports of the Philippine Commission.
Quarterly Bulletin of the Bureau of Public Works.

PORTO RICO

Road Laws

Under the Foraker Act of 1900, the commissioner of the interior of Porto Rico has charge of all insular public works, and the political code of Porto Rico subdivides his office into various divisions, of which the division of public works is intrusted with highway affairs.

The main roads of the island are 1564.4 kilometers long. Of this total, 275 kilometers were built by the Spanish government, 141.7 kilometers by the U. S. military government, and 730.9 kilometers by the civil government; the remaining sections have not yet been completed. The total completed length, including lengths in towns, is 1147.6 kilometers. These figures are only approximate, as differences exist in official reports. The 1915 report of the commissioner of the interior states: "The public

roads are, as a general rule, in bad condition, and there does not seem to be any possibility of improvement under present circumstances."

Convict Labor Laws

Convict labor is employed throughout the island on road work. The best results are obtained when it is used near towns having an insular jail, as this eliminates the extra expense and inconvenience of guarded camps.

Road Funds

The total territorial expenditure for road and bridge construction in the fiscal year 1914-15 was \$174,109, and for maintenance \$303,848.

The municipalities receive 90 per cent of all regular property taxes, 8 per cent devoted to municipal roads being included. The condition of most municipal roads is "deplorable." The municipalities spent \$138,663 on "rural roads" in 1914-15.

The insular government has sold \$1,425,000 4 per cent bonds for road construction exclusively, and \$1,000,000 4 per cent bonds for roads and public buildings.

Progress Report

During the fiscal year 1914-15, 28.1 kilometers of macadamized road were completed on seven projects having a total length of 47.3 kilometers. The cost of these projects when completed is estimated to be from \$2260 to \$21,780 per kilometer, or \$3600 to \$34,800 per mile. Little work has been done except completing existing contracts, on account of financial conditions.

Deducting roads in towns and cities, the macadam roads under maintenance in 1914-15 were 1098.8 kilometers long. The average cost of maintenance was \$262 per kilometer. The work was satisfactory with light traffic roads, but for heavy traffic roads permanent pavements of asphalt or brick are considered necessary.

Officials

Governor, Arthur Yager; commissioner of the interior, Manuel V. Domenech.

Publications

Annual Reports of Governor.

RHODE ISLAND

State Aid Legislation

The State board of public roads, consisting of five persons, one from each county, is appointed by the governor for a term of five years. The board has direct control of the expenditure of all appropriations by the legislature for road improvement, and has supervision over the construction and maintenance of all State roads.

The entire cost of construction and maintenance of State roads is paid by the State. At the close of 1915 there were 325 miles of State roads under the direct control of the State board. A State bond issue of \$600,000 was authorized in 1906 to bear 3 per cent and additional bond issues of \$600,000 in 1909 and 1912, for use in completing the system of State roads. No more than one-third nor less than one-seventh of the available appropriation in any year shall be expended in any one county. The proceeds of automobile licenses and fines are used for the repair of State roads under the direction of the State board of public roads.

In addition to the State highways, State aid is granted as follows:

Whenever any town shall make an annual appropriation equal to or in addition to the sum of 20 cents on each \$100 of taxable valuation, and whenever the electors shall vote that said appropriation be expended under the direction of the State board of public roads a sum of money equal to one-fifth of the moneys so appropriated by any town is annually appropriated by the State for the care and maintenance of the public highways and bridges of said towns. At the close of 1915 there were 1795 miles of town roads.

In 1912 legislation was enacted providing that bridges on State roads shall be under the control of the State board of public roads.

Local Road Legislation

The local roads are under the town council of the several townships, who usually appoint a highway commissioner to look after the roads.

Automobile Registration

The law provides for annual registration with the State board of public roads. The schedule of fees is as follows: 20 h.p. or less, \$5; more than 20 h.p., \$10; more than 30 h.p., \$15; more than 40 h.p., \$25; all commercial vehicles, \$7; motor cycles, \$1; dealers and manufacturers, \$50; operators, including owners, \$1.

The revenue derived from registrations, fines and forfeitures is paid into the State treasury to be used for the repair and maintenance of State roads under the direction of the State board of public roads.

Highway Officials

State Board of Public Roads, Providence.—Frank Cole, William C. Peckham, John F. Richmond, Benj. F. Robinson and Abram L. Atwood, members of board; Irving W. Patterson, engineer; Peter J. Lannon, clerk.

Road Funds

Total expenditures on trunk lines for construction to December 31, 1915, \$2,620,784.40; for reconstruction, resurfacing and repairs from 1905 to December 31, 1915, \$1,247,973.65. The State expended for reconstruction and maintenance in 1915, \$198,521.89, and for bridges \$5596.77.

The State board of public roads expect an appropriation for reconstruction to the amount of \$200,000 for 1916. The income from the automobile law will be about \$200,000 this year. All the towns of this State appropriate for their highways about \$390,000 collectively each year.

Publications

State Commissioner of Highways

Annual reports, 1896-96, to 1896-97.

State Board of Public Roads

Annual reports from 1902.

Highway News, published quarterly.

State Board of Agriculture

Annual Report, 1899. Advantages of State aid to farmers. W. W. Armstrong.

State General Assembly

Report of the joint committee to examine into the condition of roads and public highways of the State, 1895.

[Approved by PETER J. LANNON,
Clerk, State Board of Public Roads.]

SOUTH CAROLINA

State Aid Legislation

The State does not grant aid and has no highway department but considerable amount of efficient investigative and educational work is done in behalf of road improvement by the State commissioner of agriculture, Hon. E. J. Watson.

Local Road Legislation

Control over the roads is in the hands of the boards of county commissioners, with a county road supervisor or county engineer in immediate charge of the work. Road taxes are worked out. Vehicles with tires over 4 inches wide pay 25 per cent less toll on toll roads than similar vehicles with narrower tires.

Convict Labor Law

Any convict serving a sentence of six months or more, life sentence excepted, in the State penitentiary, or any county jail or upon the public works of any county, shall be entitled to have one-tenth, of such sentence deducted for good behavior.

The county supervisor of each county in the State may be allowed to use any of the convicts he may select, sentenced from his county to the State penitentiary, without charge, for the purpose of working the roads of his county, or for such other purposes as he may deem proper.

Automobile Registration

The law provides for registration with the clerk of court of the county in which the owner resides. Registration for all motor vehicles is \$1. No general provision is made for distribution of the revenue from registrations except that in 1914 an act was passed for Oconee County providing that the proceeds of registering motor vehicles therein, after deducting 5 per cent commission for collection, should go into the general road fund of the county.

Road Funds

The 1915 session of the legislature authorized Richland County to issue \$1,250,000 of 5 per cent 40-year highway bonds and Greenville County to issue \$950,000 of 5 per cent 40-year highway bonds. Other county road and bridge expenditures aside from the value of the convict labor were approximately \$1,000,000.

*Publications***State Superintendent of Public Works**

Report, 1832.

State Agricultural Experiment Station. Clemson Agricultural College

Bulletin 48. Broad and narrow tires.

Handbook of South Carolina issued by Department of Agriculture, Commerce and Immigration, 1908.

Commissioner of Agriculture, Commerce and Industries Reports for the years of 1909, 1910, 1911, 1912, 1913 and 1914.

The economic value of good roads, 1910.

Bulletin. Good roads—How to build and maintain them. M. Goode Homes, C.E., University of South Carolina, January, 1912.
Route books, 5 vols. 1912.
Washington to Atlanta highway route book.
Sanitary and Drainage Commission, Charleston County.
Annual reports, latest is for 1914.

[Approved by U. S. Office of Public Roads
and Rural Engineering.]

SOUTH DAKOTA

State Aid Legislation

A State highway department was established in July, 1913, consisting of a commission of three members, without salary. There is no provision in the road laws of the State for State aid or control of the highways, no funds being provided. The work of the commission is to give advice and conduct educational work.

Local Road Legislation

In some counties the roads are under county authorities and in other counties they are under township authorities. The road taxes are worked out.

Local Bond Legislation

It is provided in article 25, section 1137, of the revised code of 1903, that the boards of supervisors of organized townships are authorized to issue coupon bonds when directed by a two-thirds majority of the voters, at a town meeting called for that purpose. Under the amendment of 1911, chapter 250, these bonds or orders are to be payable in such amounts and at such times, not exceeding ten years from date, as two-thirds of the legal voters present and voting shall determine, with interest not exceeding 6 per cent per annum, payable annually. The section of the original article agrees with this amendment in its provision that the above action may be taken at an annual town meeting duly advertised.

Section 1139 of the original act provides that the board of supervisors must levy a tax for interest and principal not exceeding 15 per cent of such maturing bonds, and section 1140 of the original act provides that whenever a petition bearing the signatures of two-thirds of the legal voters of a township asks that an amount of money not exceeding 5 per cent of the taxable valuation of the town and not exceeding \$5000 be raised for the construction of any public road or roads, the supervisors shall issue and sell coupon bonds for the amount specified. The term shall not exceed

twenty years and the interest shall not exceed 10 per cent, payable annually, and these bonds are to be sold for not less than par value. The interest and principal are to be provided for by taxation. Money so obtained is to be used under the direction of the supervisors of the town involved.

Convict Labor Law

When in the opinion of the sheriff any convict sentenced to hard labor can be more profitably employed outside of the jail or yard, it shall be his duty to employ said convict either in work on public streets or highways or otherwise.

Automobile Registration

The law provides for annual registration with the secretary of State. The application for registration shall be filed with the county treasurer and the payment of fees made to him. The schedule of registration fees is as follows: Automobiles, \$6; motor cycles, \$2.

Twelve and one-half per cent of the gross revenue is transmitted to the secretary of State with the application to be expended in payment of costs in connection with registration. Eighty-seven and one-half per cent of the gross revenue shall be retained by such county treasurer for expenditure only in grading, crowning, draining, dragging, graveling or macadamizing public highways of the county under the direction of the board of county commissioners.

Highway Officials

State Highway Commission.—F. C. Issenhuth, chairman, Redfield; N. O. Monserud, Sioux Falls; B. M. Wood, Rapid City;

[Approved by E. C. ISSENHUTH,
Chairman, State Highway Commission.]

TENNESSEE

State Aid Legislation

In 1915 a State highway commission was created, consisting of the governor, State geologist, dean of the engineering department of the University of Tennessee, and three members appointed by the governor. The commission appoints a secretary, who must be experienced in road building. The commission is required to prepare a general highway plan of the State, showing the main roads which, when improved, will form a connected system

throughout the State; to collect statistics regarding the roads and bridges in the State; and to establish standards of road construction and maintenance for the different counties. The commission may be consulted by county and district road and bridge officers and these officers must furnish it with information concerning the roads and bridges in their charge.

The commission is authorized to execute any agreements with the Federal government incident to receiving aid from the latter.

Local Road Laws

The local roads in a county are under the county court, composed of the county judge and four lay members, who divide the county into road districts and appoint a road commissioner for each. The road commissioner appoints a road overseer for each section of his district. The county court also appoints a board of turnpike commissioners to look after toll roads in the county. If any county does not care for road districts, it may elect a county board of road commissioners, of three members, to have charge of all roads in the county.

Road Bond Laws

Under an act approved September 27, 1913, the county court of any county, when authorized by a majority vote at an election held for the purpose, may issue coupon bonds for highway purposes in any amount which will not increase the outstanding indebtedness of the county to more than 10 per cent of the taxable valuation. These bonds shall bear interest at not exceeding 6 per cent, shall not run for more than forty years, and shall not be sold for less than par; provided that a two-thirds vote may authorize a bond issue that may increase the outstanding indebtedness to an amount not to exceed 15 per cent. The county court provides the levy for interest and retiring the bonds and also for creating an annual maintenance fund equal to 2 per cent of the bond issue.

In case of federal aid, the court is authorized to appropriate an amount not to exceed double the federal aid, and, in case there are insufficient funds in the treasury, may issue bonds not to exceed 3 per cent of the taxable valuation.

Convict Labor Laws

County convicts may be worked upon the public highways of the county, subject to the direction of the county court. State and county convicts may be worked by the State highway commission.

The report as to the health conditions of the State penitentiary show 34.4 per cent tuberculosis infection, which has created a strong sentiment for a constitutional amendment to place the entire convict force of Tennessee upon the public roads, abolishing its convict lease system.

Automobile Registration

Motor vehicles are registered with the secretary of State. The fees are \$5 for automobiles for four persons or less, auto trucks and traction engines, \$7.50 for automobiles for more than four persons, \$2.50 for motor cycles, \$1 for registration of license with clerk of county where owner resides, \$10 for dealers. Ten per cent of the proceeds are reserved for the maintenance of the State highway commission and the remainder forms a State highway fund spent under the direction of the State highway commission for the maintenance of roads in the several counties in proportion to the registration fees collected in them.

Highway Officials

State Highway Commissioners.—Governor Tom C. Rye, Dean Chas. E. Ferris, Dr. A. H. Purdue, Arthur Crownover, W. H. Crox and Chas. F. Williams. Secretary, J. J. Murray, Nashville.

Road Funds

There were no State road funds available in 1915. County bond issues and appropriations yielded about \$8,000,000.

For 1916, about \$125,000 will be available from automobile registration for the maintenance of roads in the general highway plan. An equal amount will be furnished by the counties to be spent under State supervision. The bonds for sale in Tennessee on January 6, 1916, amounted to \$3,500,000. The estimated county appropriations for roads in 1916 amount to \$9,000,000.

Publications

State Highway Commission

Special message of Governor Malcolm R. Patterson to the 57th General Assembly, January, 1911.

State Agricultural Experiment Station

Bulletin, vol. 3, no. 3, 1900. Road construction.

[Approved by J. J. MURRAY,
Secretary, State Department of Highways.]

TEXAS

State Aid Legislation

The State has no highway department and grants no aid to road improvement.

Local Road Legislation

The local roads are under the charge of the county courts. Where a county judge is chairman of a county court he usually appoints the county engineer or superintendent, while elsewhere the court makes the appointment. Road taxes are worked out.

Local Bond Legislation

Any county, political subdivision, or other defined district of the county, upon a vote of two-thirds majority of the resident, property-holding taxpayers, may issue bonds for road purposes in an amount not to exceed one-fourth of the assessed value of the real property therein. These bonds shall run for not less than twenty nor more than forty years, with such option of redemption as may be fixed by the commissioners' court, shall bear not more than 5½ per cent interest per annum, and must be examined by the attorney general and registered by the state comptroller of public accounts. The county commissioner's court shall levy a tax sufficient to pay the interest on these bonds and produce a sinking fund sufficient to redeem them at maturity. Each political subdivision or defined district so issuing bonds shall be made a body corporate, and may sue and be sued in like manner as counties. The county commissioner in whose precinct the political subdivision or defined district is located shall be ex-officio road superintendent of the road district, with power to contract for and on behalf of it.

Convict Labor Legislation

The commissioners court may require all male county convicts, not otherwise employed, to labor upon the public highways under such regulations as may be deemed most expedient. Each convict worked on the roads in satisfaction of any fine and cost shall receive a credit thereon of 50 cents for each day he may labor and reasonable commutation of time may be granted as a reward for faithful service and good behavior, provided same shall not exceed one-tenth of the whole time.

Automobile Registration

The law makes provision for registration with the clerk of the county in which any motor vehicle owner resides. The registration fee is 50 cents.

The revenue from registrations apparently goes to the clerk making the registration.

Progress Report

No State highway department has yet been established and it has been impracticable to obtain a comprehensive report showing the progress of road improvement throughout the State. The county is the unit of administration in Texas and a large number of the counties have made great progress through the issuance of bonds.

*Publications***State University—Mineral Survey**

Bulletins, 1901 to 1904. Nine volumes. 1. Texas petroleum, 1901. 3. Coal, lignite and asphalt rocks, 1902.

Department of Agriculture

Bulletin 38. East Texas—Its topography, soil, temperature, agricultural products, people, rainfall, climate, streams, etc. By R. T. Milner.

Agricultural and Mechanical College, Division of Highway Engineering,
Bulletin (volume 1, no. 1). The benefits of good roads. By Robert J. Potts.

Bulletin (volume 1, no. 2). Earth roads. By R. L. Morrison.

Bulletin (volume 1, no. 5). Highways, bridges, and culverts. By B. K. Coghlan.

Bulletin (volume 1, no. 8). Gravel roads. By B. K. Coghlan.

Bulletin (volume 1, no. 7). Highway engineering.

University of Texas

Bulletin 62, 1915. Road materials of Texas. By James P. Nash, testing engineer.

[Approved by U. S. Office of
Public Roads and Rural Engineering.]

UTAH*State Aid Legislation*

The State road commission consists of the governor, the State engineer, the State treasurer, one member of the faculty of the Agricultural College of Utah and one member of the faculty of the University of Utah, all of whom serve without compensation. The commission designates the roads which comprise the system of State roads; has charge of the expenditure of the State road building fund; furnishes plans, specifications and estimates for culverts, bridges and road construction on application of county

commissioners; tests road materials, conducts experiments and investigations with reference to road construction when deemed necessary and prepares and issues a manual of road building and maintenance for information and guidance of public and local officials; keeps all maps, profiles and papers in the office of the commission for public inspection and reference; submits report biennially to the governor.

An appropriation is made from the general revenues of the State as a State road fund. This fund is available for the construction and maintenance of State roads in each county in equal proportions. The law requires counties having an assessed valuation under \$2,000,000 to duplicate one-fourth of the amount of the State road fund appropriated by the State for such counties, and counties having an assessed valuation of more than \$2,000,000 and less than \$4,000,000 to duplicate one-half of the amount, and counties having an assessed valuation of more than \$4,000,000 to duplicate the full amount. The State road commission gives notice of intention of road improvement, including amount of money available in State fund for the county, general outline of work, the amount of special tax levy to be placed on property in county not later than June 1 of each year. The county commissioners accept or reject requirements of the State road commission within thirty days of receiving proposal from the latter. In case of acceptance the county commissioners are required to levy the special road tax, which is not to exceed 5 mills on all taxable property within the county, the amount thus realized to be used in connection with the county appropriation and State road building fund but not in lieu of the amount to be appropriated by the county. Should the county default in the payment of its proportion after its acceptance of the requirements, the State road commission is authorized to collect the amount of the default from any moneys due the county in the hands of the State treasurer. If the county commissioners of a county fail to accept the proposal of the State road commission within the time limit specified, the county forfeits its right to its proportion of the State road fund for that year which remains a part of the State road fund to be apportioned the following year.

Where the streets of any city are or become a part of the system of State roads, the city may levy a special tax, not exceeding two mills, to be used in connection with the State road fund on the portion of the State road system within the city and to be expended under the direction of the State road commission.

The State road commission makes all plans, specifications and estimates for the improvements of State roads and awards contracts. State roads are kept in repair by the State road commission.

Local Road Legislation

Jurisdiction vests in elected boards of county commissioners, each of which is required to appoint a road commissioner annually.

Local Bond Legislation

The board of county commissioners may contract bonded indebtedness by an order specifying the purpose for which the indebtedness is to be created and the amount of the indebtedness, and by providing for submission of the proposition to the electors of the county at the next succeeding general election, or at a special election to be called for that purpose. At this election only such qualified voters as have paid a property tax in the county in the year preceding the election shall be permitted to vote on the question of issuing bonds. A majority of those voting shall be necessary to authorize the issuance of bonds. If the bonds are issued, the board shall levy a tax necessary to pay the interest on them and to create a sinking fund for their redemption at maturity. Bonds shall not be in an amount which, including existing indebtedness, will exceed 2 per cent of the value of the taxable property of the county.

Convict Labor Legislation

Convict labor may be utilized in providing road material and also actual construction. Prisoners in the county jail may be required to work on the county roads under regulations made by the board of county commissioners, and prisoners in the State prison may be required to work on the State roads.

When State prison convicts are used in the construction or improvement of any State road, the work shall be under the authority and control of the State road commission, the State board of correction and the warden of the Utah State prison.

The State board of pardons is required to make provision for granting privileges and reduction of sentence for good behavior on part of convicts employed on roads.

Automobile Registration

The law provides for registration with the secretary of State. The registration fees are as follows: \$3 for each motor cycle, \$10 for each electric motor vehicle used only for pleasure purposes, \$10 for each commercial motor vehicle used for carrying passengers for hire, \$10 for each commercial vehicle or truck, \$5 for every other motor vehicle not exceeding 25 h.p., \$10 for every other motor vehicle exceeding 25 but not exceeding 40 h.p., \$15 for

every other motor vehicle exceeding 40 h.p.; chauffeur's license, \$2.

The registration revenues are paid into the State treasury and there credited to the State road fund to be expended under the direction of the State road department.

Highway Officials

State Road Commission, Salt Lake City; Wm. Spry, chairman; Richard R. Lyman, vice-chairman; W. D. Beers, Jesse D. Jewkes and Wm. Peterson. E. R. Morgan, State road engineer and secretary. The road commission appoints a State agent in each county to take charge of State road work.

Road Funds

An annual appropriation of \$108,000 is made from the general revenues of the State for a State road fund.

Publications

State Road Commission

- First biennial report, 1909-10.
- Second biennial report, 1911-12.
- Road laws of the State, 1909.
- Road and highway laws, 1912.
- Third biennial report, 1913-14.

State University—State School of Mines

- Bulletin 2. Tests of macadam rock.
- Bulletin 3. Construction and maintenance of earth roads.
- Bulletin 4. Economical design of reinforced concrete.

State Engineer

- Fourth biennial report, 1903-04.
- Fifth biennial report, 1905-06.
- Sixth biennial report, 1907-08.
- Seventh biennial report, 1909-10.
- Eighth biennial report, 1911-12.
- Ninth biennial report, 1913-14.

[Approved by E. R. MORGAN, State Road Engineer.]

VERMONT

State Aid Legislation

The State highway commissioner is appointed by the governor for a term of two years, and has control over the expenditures of all moneys appropriated by the State for highway purposes. He shall annually allot the same to the town road commissioners, and furnish plans, specifications, and advice. He appoints not to exceed one supervisor for each county to assist him in the

performance of his duties. The State highway commissioner meets the road and street commissioners of the several towns and villages at least once annually, and these commissioners receive their per diem and necessary expenses for attending the meetings.

The selectmen and town commissioners select the roads on which State aid shall be expended, but such selection is subject to the approval of the State highway commissioner. The selectmen and the State highway commissioner may agree upon any plan of expenditure deemed best in any such town.

A State highway tax of 5 cents on each \$100 is annually assessed and the amount thus derived is apportioned to the towns upon the basis of the road mileage therein, which shall be certified to the State treasurer by the selectmen. A direct appropriation is made to be available to cities and towns, excepting incorporated villages, as follows: When a town shall vote to raise money in addition to the amount required by law, an amount shall be apportioned to the town equal to the excess amount, provided it is not less than \$100 or more than \$1000 in any one year.

Provision is made for the supplying engineering services and for State aid on the building or rebuilding of bridges of less than 30 foot span. The amount of State aid is not to exceed 25 per cent of the cost of the bridge, and in no case to exceed \$300. The appropriation is \$15,000 for this purpose.

Provision is also made for towns and State to unite in maintaining certain approved State roads under the patrol system, the town appropriating a proper amount and the State supplying the balance.

Local Road Legislation

One or two road commissioners are elected by the town each year, or they may be appointed by the selectmen, providing the town votes them the authority. The county court annually appoints three persons as county road commissioners.

Local Bond Legislation

Any town or incorporated city may issue bonds to an amount not exceeding three times its grand list for the purpose of purchasing road-making apparatus and building permanent highways therein. To authorize such bonds a two-thirds majority vote of all those cast at a meeting of the town or corporation for that purpose shall be necessary. These bonds shall be issued for a term not exceeding twenty-five years, with interest coupons attached bearing not to exceed 5 per cent interest. The town, city or village must by vote determine the time, place, manner of payment, and the terms, denominations and conditions of such bonds.

Convict Labor Legislation

The sheriffs of the several counties may employ or cause to be employed able-bodied prisoners confined in county jails, upon conviction for crime, in the improvement of the public highways within a radius of 30 miles from such jail and outside of a city or incorporated village. The county sheriff makes necessary rules for the proper care of such prisoners subject to the approval of the attorney-general and governor. The State highway commissioner shall designate subject to the approval of the sheriff the highways upon which labor shall be employed. The highway commissioner or his assistants shall direct the work.

Automobile Registration

The law provides for annual registration with the secretary of State. The schedule of fees is as follows: First registration, per h.p., \$1; second registration, per h.p., 75 cents; third and subsequent registrations, per h.p., 50 cents; operators, including owners, \$2.00; manufacturers and dealers, \$25.

The net registration revenue is paid into the State treasury to be expended for the repair and maintenance of main thoroughfares and State roads under the direction of the State highway commissioner.

Highway Officials

State highway commissioner, Stoddard B. Bates; clerk, M. E. Shedd; office, Franklin.

Progress Report

Of the 15,000 miles of roads in the State, about 4000 miles were improved in 1915 at a total cost of about \$450,000. About \$200,000 was spent on maintenance. The plan of improvement is to concentrate the work on the worst places on the 4000 miles of main roads instead of building long stretches of new roads. In this way the main roads have no very poor sections, after the spring thaws are over; about 200 miles of road, all told, were built in this way in 1915. Gravel roads seem to answer Vermont conditions most satisfactorily.

In 1913 a beginning was made in systematic maintenance by establishing about 70 miles of patrol routes on the trunk roads. These routes were increased to 280 miles in 1914 and 445 miles in 1915.

Road Funds

State appropriations for 1916, \$200,000; voted by towns to get State aid (estimated), \$125,000; 5 per cent tax apportionment, \$120,000; total \$445,000.

For maintenance of the State roads only, there will be expended by the State an estimate of \$140,000; expended by the towns, a minimum, \$140,000; total \$280,000.

Publications

State Highway Commissioner

Reports, first to eighth; 1899-1900 to 1913-14.

State Board of Agriculture

Biennial Report, second, 1873-74. Highways. A. B. Halbert.

State Legislature—Senate

Journal 1855. Report of committee on roads.

[Approved by M. E. SHEDD, Clerk, State Highway Commission.]

VIRGINIA

State Aid Legislation

A State highway commissioner is appointed by the governor, with the consent of the general assembly, for a term of six years. The commissioner, together with the professors of civil engineering of the University of Virginia, the Virginia Military Institute, and the Virginia Polytechnic Institute, constitute the State highway commission. The State highway commissioner is required to be a citizen of the State and a civil engineer versed in road building.

The State highway commissioner has supervision of the construction and maintenance of main-traveled roads of the State, may recommend to the governor and local authorities needed improvements, collect information and disseminate the same, and give advice.

Whenever the local authorities of any county desire to permanently improve any main road, they may make application to the State highway commissioner. If he approve such application he shall prepare plans, specifications, and estimates and submit a copy of same to the local authorities. If they decide to improve said road, they may make application to the State commissioner for State aid, which may be money aid or convict labor. If money aid is desired, the local authorities shall agree that the county will bear one-half of the cost of improvement and the State highway commissioner shall advertise for bids and the local authorities award the contract subject to the approval of the State highway commissioner. The work shall be done under his supervision. The money aid is apportioned among the counties of the State according to the total amount of State taxes paid by the respective counties. If a county pays more than 50 per cent of the expense it shall be entitled to receive

annual apportionment until the receipts from the State shall equal 50 per cent of the cost of such permanent improvement.

If convict labor is desired, the local authorities shall undertake to supply necessary materials, tools, and teams, and have the work done under the supervision of a civil engineer, to be supplied by the State highway commissioner, at a salary not to exceed \$1200 a year, to be paid by the county. The State commissioner then makes requisition on the superintendent of the penitentiary for such convicts as he may deem necessary. If the local authorities desire to do the work by contract, the labor of the convicts may be estimated at \$1 per 10 hour day, and the State grant in this way not more than 40 per cent of the contract price. Counties may not receive both convict labor and money aid in the same year. Any county may use its apportionment of State money in the construction of bridges, and any county may determine what part of its 50 per cent of the cost of road or bridge construction shall be borne by the sub-divisions of the county.

Whenever any county or district shall issue bonds for road improvement, application shall be made to the State highway commissioner for a competent highway engineer to make plans and specifications and supervise the work, which shall be awarded to contract jointly by the State highway commissioner and the local authorities. The proceeds of automobile fees are expended under the direction of the State highway commissioner.

Local Road Legislation

Jurisdiction over roads vests in the county boards of supervisors. Each board is authorized to appoint a county road superintendent or a road superintendent for each magisterial district or group of districts, or it may appoint both county and district superintendents.

Local Bond Legislation

Upon the petition of a majority of the board of supervisors of any county or upon the petition of 150 freeholders of a county to the circuit court thereof, the circuit court may order an election to determine whether the board of supervisors of the county shall issue county bonds for road purposes. A majority of the qualified voters of the county will be necessary. The amount of the bonds, including all bonds previously issued and remaining unpaid, shall in no case exceed 10 per cent of the total taxable value of the county. These bonds shall be issued in denominations of \$100 or some multiple thereof, shall bear not to exceed 6 per cent interest, and shall be payable not exceeding thirty-four years from the date thereof,

but may, in the discretion of the board of supervisors, be made redeemable at such time or times as the board may prescribe and stipulate upon the face of the bonds when issued. After the issuance of the bonds, a tax shall be levied in the county on all property liable to State tax to an amount sufficient to meet the interest on the bonds and create a sinking fund for their redemption at maturity.

The board of supervisors, or local county road board if there be one, shall apply to the State highway commissioner for, or shall employ a competent road engineer to make plans and specifications for and supervise the improvements made from the proceeds of the bond issue.

Bonds may be issued by any county for the purpose of macadamizing or otherwise improving the public roads and bridges of any magisterial or road district in such county. Before the bonds are issued, a petition signed by a majority of the board of supervisors of the county or by fifty freeholders of any magisterial district or districts in the county shall be presented to the circuit court of the county, which shall order an election to be held to determine whether the bonds shall be issued. A majority of the qualified voters of the district voting thereon shall be necessary to carry the election. The amount of these bonds shall not exceed 10 per cent of the total assessed taxable values at the time in the magisterial district. These bonds shall be in denominations of \$100 or some multiple thereof, shall bear not exceeding 6 per cent interest per annum, and shall be payable within not exceeding thirty-four years from the date thereof, but may, in the discretion of the board, be made redeemable at such time or times and upon such notice as the board may prescribe and stipulate upon the face of the bonds when issued. The necessary tax levy shall be made by the board on all taxable property liable to State tax in the magisterial district, in order to meet the interest on the bonds and to create a sinking fund for their redemption at maturity.

Under a clause in article 5 of chapter 76 of the laws of 1908, when more than 50 per cent of the expense of permanent road improvement in any county is expended in accordance with provisions of the act, that county shall be entitled to receive its annual apportionment of State aid until its receipt from the State on that account shall equal 50 per cent of the expense.

Convict Labor Legislation

After May 1, 1913, all male prisoners confined in the State penitentiary shall be subject to work on the State convict road force, except those considered unsafe by the superintendent. The road force shall be under the direction of a civil engineer

appointed by the State highway commissioner, or of a guard so appointed who shall be well versed in road building. When local road authorities desire to make permanent improvement by contract, the State may furnish such force of convicts that at \$1 per day will amount to 40 per cent of the contract price.

Automobile Registration

The law provides for annual registration with the secretary of State. The schedule of fees is as follows: 20 h.p. and less, \$5; 21 to 44 h.p., \$10; 45 h.p. and over, \$20; motor cycles, \$2; manufacturers and dealers, \$50; chauffeur's license, \$2.50.

The net registration revenue is paid into the State treasury to be credited to a special fund for expenditure in permanent improvements of the main highways of the State, under the direction of the State highway commissioner and in accordance with the State aid highway act of 1908.

Highway Officials

State Highway Commission, Richmond.—G. P. Coleman, State highway commissioner; Wm. M. Thornton, dean, engineering department, University of Virginia; Col. T. A. Jones, professor of civil engineering, Virginia Military Institute; R. B. H. Begg, dean engineering department, Virginia Polytechnic Institute; C. B. Scott, assistant commissioner; B. Atkins, clerk; D. McDonald, W. F. Cocke, F. D. Henley, A. H. Pettigrew, S. L. von Gemmingen and C. S. Mullin, division engineers; C. D. Snead, bridge engineer.

Progress Report

Roads built during the year ending September 30, 1918

	<i>Miles</i>	<i>Cost</i>	<i>Average cost per mile</i>
Macadam—Money aid.....	84.25	\$382,517.19	\$4,302.87
Macadam—Convict labor.....	74.01	294,760.55	3,892.71
	158.26	657,277.74	4,153.15
Previously graded			
Macadam—Money aid.....	27.67	72,978.38	2,637.45
Macadam—Convict labor.....	2.55	6,432.43	2,522.52
	30.22	79,410.81	2,627.75
Bituminous macadam—Money aid.	15.37	146,915.03	9,558.55
Bituminous macadam—Convict labor.....	4.51	34,823.20	7,721.33
	19.88	181,738.23	9,141.76
Bituminous macadam—money aid (previously graded).....	1.65	5,562.78	3,371.33
Gravel—Money aid.	89.07	209,583.86	2,353.02
Gravel—Convict labor.....	21.26	40,318.63	1,896.45
	110.33	249,902.49	2,265.08

	<i>Miles</i>	<i>Cost</i>	<i>Average cost per mile</i>
Shell—Money aid.....	4.51	\$8,108.54	\$1,797.90
Shale—Convict labor.....	3.29	10,213.36	3,104.36
Soil or sand-clay—Money aid.....	259.29	225,432.85	869.42
Soil or sand-clay—Convict labor...	106.80	143,689.27	1,345.40
	366.09	369,122.12	1,008.28
Grading—Money aid.....	125.65	265,696.45	2,114.57
Grading—Convict labor.....	26.67	66,158.13	2,480.62
	152.32	331,854.58	2,178.67
Surface treatment of old macadam			
—Money aid.....	40.34	18,868.81	467.74
Surface treatment—Convict labor.	8.37	6,942.43	829.44
	48.71	25,811.24	529.89

Bonds issued for road building since October 1, 1914

Buckingham.....	\$50,000.00
Fairfax (Providence District).....	50,000.00
Lunenburg (Lewiston and Lochleven).....	65,000.00
Mechlenburg (Bluestone District).....	80,000.00
Montgomery (Christiansburg District).....	100,000.00
Nelson (Lovingston District).....	35,000.00
Northampton (Eastville).....	50,000.00
Prince William (Occoquan).....	16,000.00
	\$396,000.00
To October 1, 1914.....	\$6,675,100.00
Total.....	\$7,071,100.00

Road Funds

The State contributed to road and bridge construction in the various counties approximately \$500,000, which, together with bond issue funds and amounts raised locally by the counties, makes a total for the year of \$2,002,206.72 expended in the construction of 846 miles of road and 70 bridges.

The State appropriated for 1915 \$185,000 as cash State aid, \$200,000 for maintenance of State convict force, and derived about \$170,000 from automobile fees, or a total of \$555,000.

Publications

Agricultural State Experiment Station
 Bulletin 34, 1893. Road improvement.
 State Highway Commissioner
 Annual Reports, first to seventh; 1906-07 to 1910-11, 1912, 1913, 1914.
 State Board of Public Works
 Reports, 1816, 1818, 1819-20, 1823 to 1847, 1849 to 1855, 1866 to 1876.

[Approved by GEORGE P. COLEMAN,
 State Highway Commissioner.]

WASHINGTON

State Aid Legislation

The public highway fund is derived from a tax of one mill on all property, and is used for the construction of State roads. A system of primary and secondary State roads has been established by the legislature; primary State roads are built and maintained by the State; secondary State roads are built by the State and maintained by the counties. The legislature makes appropriations from the public highway fund for construction of designated portions of the State roads, and for the maintenance of the State highway department. Seven and one-half per cent of the public highway fund is set aside for maintenance of primary highways. Construction and maintenance of State roads is under the direction of the State highway commissioner, appointed by the governor for a term of four years. He is required to compile statistics relating to public highways throughout the State, give advice to local officials, and make recommendations as to needs of highways, with estimated cost; he is also charged with special investigations and duties by the legislature. The State highway board apportions the amounts appropriated by the legislature for any State road to be expended within the boundaries of the several counties through which the road may pass; awards all construction contracts; and decides matters of general policy in connection with the work of the State highway commissioner.

The permanent highway fund is derived from a tax of 1.5 mills on all property; is paid into the State treasury and credited to each county in the full amount paid by such county. It is expended on contracts for surfaced road construction, under certain statutory restrictions. A road improvement under this law may be initiated by the board of county commissioners on its own motion, when the entire cost of construction, except engineering supervision, is paid from the fund; or may be initiated by a petition signed by the owners of not less than two-thirds of the property fronting on the section of the road to be improved, in which case at least 15 per cent of the cost is assessed to the abutting property. Plans and specifications for such work are prepared by the county engineer, subject to the approval of the State highway commissioner. All payments made for such work have to be approved by the State highway commissioner, who also examines and accepts the completed contracts. The expenses of the county engineer in connection with these improvements are paid from the general county funds; the expenses of the State highway commissioner are paid from his office appropriations. Five per cent of the fund is set aside for the maintenance of roads constructed under the provisions of the act.

The State highway board is authorized to establish State quarries to be operated by convict labor. The material prepared at such quarries is used on State roads, or by any city, town or county after the State road requirements have been met, or may be sold in the open market after State and municipal needs are satisfied, at a price of not less than 10 per cent above the estimated cost of production at place of delivery.

Local Road Laws

The roads of a county not under the township system are in charge of the board of county commissioners. The board divides the county into districts and appoints a supervisor for each. A county engineer is elected biennially.

Where a county has adopted the township system, the roads are under the commissioners or supervisors of each township.

Local Bond Legislation

There are in Washington three operative statutes passed and effective in the years 1890, 1893 and 1913, respectively. The last two are very similar, and the act of 1913, as therein stated, is intended to confer additional power and authority. Bonds may be issued under the provisions of either of these statutes.

The board of county commissioners of any county may, by the act of 1890, whenever a majority of them shall so decide, submit to an election the question of issuing coupon road and bridge bonds in an amount not to exceed 5 per cent of the taxable property in the county, bearing not to exceed 6 per cent interest per annum, and payable at such time as may be fixed by the board of county commissioners. This proposition may be submitted at a general election and a majority of three-fifths of the votes cast is necessary to authorize the issue of these bonds. If bonds are issued, the county commissioners must ascertain and levy annually a sufficient tax to pay the interest on them when they become due and to create a sinking fund to redeem them at maturity.

The county commissioners are authorized by the act of 1893 to establish and construct a system of improved roads on petition setting forth that the public welfare requires that such improvements should be begun without delay and that the county has not sufficient funds. If the commission shall approve the petition, they may by resolution direct that an election be called on the question of issuing bonds of the county to provide funds. If three-fifths of those voting are favorable, the commissioners shall issue the bonds and negotiate their sale at not less than par value. These bonds shall be made payable to the bearer within not more than twenty years from their date and shall bear not exceeding 6

per cent interest. Bonds shall not be issued under the provisions of this chapter in such an amount as will make the aggregate indebtedness of the county exceed $1\frac{1}{2}$ per cent of the value of taxable property therein. When bonds are issued, the board of county commissioners is authorized and required annually to levy and collect a tax sufficient to pay the interest on them, and, in case they are to run longer than ten years, they shall annually levy and collect, beginning with the annual tax levy succeeding the expiration of ten years from the date of the bonds, an additional tax to provide a sinking fund for the payment of the principal thereof. This annual sinking fund levy shall be at least equal to 10 per cent of the amount of the bonds issued.

An act passed in 1913 authorizes the board of county commissioners of any county to submit to the voters of the county the question of issuing negotiable coupon road bonds in an amount not to exceed 5 per cent of the taxable property of such county. This question may be submitted at the general election or at a special election called for that purpose. A three-fifths majority of the votes cast shall be necessary to authorize the issuance of the bonds. If issued, they shall run not to exceed twenty years and bear not to exceed 6 per cent interest. The provisions of this act shall apply not only to roads which are or shall be under the general control of the county, but also to all parts of the State roads in the county and to all roads which are situated or are to be constructed wholly or in part within the limits of any incorporated city or town therein; provided that the board of county commissioners finds that they form or will become a part of the public highway system of the county; provided further that no proposition for bonds shall be submitted which proposes that more than 40 per cent of the proceeds thereof shall be expended within any city or town or within any number of cities and towns. After the bonds are issued, the county commissioners shall levy an annual tax sufficient to pay the interest and at least five years prior to the maturity of the bonds, and thence forward each year until their maturity the county commissioners must ascertain and levy a tax sufficient to accumulate during the last series of years a fund equal to the principal of all the bonds then remaining outstanding and unpaid. The proceeds of this tax shall go into a sinking fund for the discharge of the bonds.

Convict Labor Law

Whenever there are persons confined in the State penitentiary who are physically able to perform manual labor upon the public highways and who shall not be engaged in other work required by the State board of control, the same may be employed upon the

construction and improvement of the public highways within the State.

The board of control shall monthly certify to the State highway commissioner the number of persons in the institution named who may be used for the work authorized under this act, and the state highway commissioner shall, whenever possible use such persons in the building or repair of public roads.

All work shall be under direction and supervision of the State highway commissioner, but the control and management of the convicts shall be under the supervision of the State board of control. All expense of care, maintenance and transportation above 25 cents per day for each convict shall be paid from the funds authorized to be used on the road being improved. Twenty-five cents per day shall be paid from the fund appropriated for the maintenance of the penitentiary.

County commissioners may order jail prisoners to work on the public roads under direction of the sheriff at a distance of not to exceed 5 miles from place of detention.

Automobile Registration

Application for a motor vehicle license is made to the county auditor, and is forwarded to the secretary of State, who issues a license and number plates.

The annual license fees are based on horse power and capacity, as follows:

All motor cycles, \$2.50.

Automobiles, 25 h.p. or under, \$3; 25 to 40 h.p., \$5; 40 h.p. and over, \$7.50; public, per horse power, 50 cents.

Motor trucks, under 2 tons capacity, \$10; 2 tons and under 3, \$15; 3 tons and under 4, \$20; 4 tons and not over 5, \$25.

Motor trucks for hire, under 2 tons capacity, \$20; 2 tons and under 3, \$30; 3 tons and under 4, \$40; 4 tons and not over 5, \$50.

Auto stages pay at the rate of 50 cents per horse-power and in addition \$1 per passenger capacity of the vehicle.

Demonstration motor cycles, \$3; all other demonstration motor vehicles, regardless of horse-power or capacity, \$5.

The costs of administration of the law are paid from the receipts of fees. The balance of the fees is paid into the permanent highway maintenance fund. Fines are paid into the same fund.

Highway Officials

State Highway Board, Olympia.—Governor Ernest Lister, chairman; Thomas G. Bush, Acting State highway commissioner, secretary; Edward Meath. State treasurer; C. W. Clausen. State auditor. and Charles A. Reynolds, chairman of the public service commission.

Road Funds

The 1915 legislature appropriated \$2,152,288 for State roads for the two years ending March 31, 1917, and reappropriated \$153,640 for that purpose; it also appropriated \$4,000,000 for permanent highways. It was estimated that \$4,000,000 of county funds would also be spent during the two years.

*Publications***State Highway Department**

Bulletin 1. State and county road laws by legislature of 1907.

Bulletin 2. Report to Governor of Washington on convict labor on State roads.

Bulletin 3. State aid roads.

State investigating committee, highway department. Report of the board of control on State rock crushing plants; working convicts on State roads and at crushing plants.

Biennial reports, 1906, 1908, 1910, 1912.

State Agricultural Experiment Station

Bulletin 39. 1899. Road improvement.

State Geological Survey

Bulletin 2. The road materials of Washington.

[Approved by Wm. R. Ror, Ex-State Highway Commissioner.]

WEST VIRGINIA*State Aid Legislation*

At the 1913 session of the legislature a law was enacted establishing a State road bureau consisting of the professor in charge of the railway and highway department of the State university to be chief road engineer and chairman of the bureau; the director of the State experiment station and two additional members to be appointed by the governor. Both of these two members shall not be appointed from the same political party. The professor in charge of the railway and highway department at the State university is to be appointed by the governor. The bureau is to give instruction and advice in road building, collect data, test materials, and have such supervision of the roads of the State as is consistent with the constitutional provision on this subject and to see that all road laws are enforced.

The State grants aid to the counties in the form of convict labor to be employed under the supervision and in accordance with the plans and specifications of the State road bureau.

The road bureau is stationed at the University and a highway laboratory has been established preparatory to testing road materials.

A special course in highway engineering has been provided. The law requires all county road engineers to attend this course for at least 10 days in each year. About 150 attend.

Road Bond Legislation

The county court of any county may improve the main roads thereof, and may pay for them by the issuance of the bonds of the county. In this case the court, upon petition of fifty legal voters of the county, shall submit the proposition at a general school or special election, and a three-fifths favorable vote of all votes cast shall be necessary to authorize the issuance of the bonds. The amount of bonded indebtedness that may be outstanding at any one time shall not exceed 5 per cent of the value of the taxable property within the county. Interest on these bonds shall not exceed 6 per cent, and the bonds shall be sold at not less than par. The term not exceed thirty-four years, and an annual tax shall be levied on all property subject to taxation in the county sufficient to meet the interest and to create a sinking fund for the redemption of the bonds at maturity.

In like manner the county court may issue road bonds of any magisterial district within the county.

Local Road Legislation

Three county commissioners, elected for six years, one every two years in November at regular elections, have control of roads. The county commissioners may appoint a county engineer to serve one year.

Convict Labor Laws

Circuit, criminal and justice courts shall sentence convicts to work on roads and bridges under the county court, its agents or engineer. County courts may apply to the State board of control for State prisoners to work upon the State highways of the county. The application will be granted if prisoners are available, provided the State board of control may for good cause refuse to grant any application. A total of 72,531 days' work was done by convicts on roads in 1915.

Road Funds

There are no State funds for road work; the appropriation for the State road bureau is \$10,300.

The levies for road and bridge purposes for 1915-16 were \$1,900,000 and county bonds to the amount of \$5,413,000 were voted.

Automobile Registration

The law provides for annual registration with the State auditor. The fee for motor vehicle registration is \$10. Chauffeur's license (perpetual) \$2. The registration revenue is not applied to roads but goes into the general fund of the State.

Highway Officials

State Road Bureau.—A. D. Williams, chairman and chief road engineer, Morgantown; the director of the State experiment station ex-officio and two members appointed by the governor. Personnel John Lee Coulter, Morgantown; A. H. Groy, Cameron; J. W. Lynch, Union.

*Publications***State Highway Inspector**

Partial report, 1908.

State Department of Public Roads

Biennial Report, first, 1909-10.

Circular, September, 1909. Construction and use of split-log drag.

Circular, August, 1910.

Circular, September, 1910.

Circular, October, 1910.

Bulletin 1. Road drags, their construction and use. H. E. Williams.

Bulletin 2. To the county road engineers.

Bulletin 3. Opinion of the attorney general in regard to the road and bridge funds of West Virginia.

State road map, 1911.

Bulletin 1. Road law, July, 1913.

Bulletin 2. Road officials, February, 1914. County and State.

Bulletin 3. Road drags, construction and use.

Bulletin 4. Prison labor.

Bulletin 5. Earth and sand clay roads.

Bulletin 6. Program road school, 1914.

Bulletin 7. Study of West Virginia sands.

Bulletin 8. General specifications for steel highway bridges.

Bulletin 9. General specifications for concrete highway bridges.

Bulletin 10. General specifications for substructures highway bridges.

Bulletin 11. Testing of road materials and laboratory report.

Bulletin 12. Specifications and contract for highway constructions.

Bulletin 13. Specifications and contract for macadam highway constructions.

Bulletin 14. Specifications and contract for concrete highway constructions.

Bulletin 15. Specifications and contract for brick highway constructions.

Bulletin 16. Culverts and drains.

Bulletin 17. Rules for surveyors and camps, prison work, etc.

Bulletin 18. Proceedings road school, 1914.

Bulletin 19. First annual report State road bureau.

Bulletin 20. Program road school, 1915.

Bulletin 21. Second annual report.

Bulletin 22. Road bonds, laws and tables.

Bulletin 23. Program of road school, 1916.

- Circular 1. Sign posts.
- Circular 2. Rules for testing material.
- Circular 3. Duties county officials.
- Circular 4. Suggestions for good roads days, May 28, 29, 1914.
- Circular 5. Our roads and resources.
- Circular 6. Grades and excavation.
- Circular 7. Instructions to county court.
- Circular 8. The young man's interest in good roads.
- Circular 9. The young woman's interest in good roads.
- Circular 10. Judge Wood's decision on road and bridge contract notices.

[Approved by A. D. WILLIAMS, Chief Road Engineer.]

WISCONSIN

State Aid Legislation

The State highway commission consists of five members, who are non-paid except actual expenses. Three members are appointed by the governor. The dean of the College of Engineering at the University of Wisconsin and the State geologist are members ex-officio. The State highway engineer is appointed by the State engineer with the approval of the State highway commission.

The boards of county supervisors are required to select a continuous system of roads known as the county system of prospective State highways. These roads may be constructed by the town, county and State jointly, or by the county and State jointly. In the former case, the town, county and State each assume one-third of the cost; in the latter case, the county assumes three-fifths of the cost and the State two-fifths. This applies to both road and bridge construction.

Improvements on this road system are made by a county highway commissioner, elected by the county board, under the general directions and in accordance with the plans and specifications of the State highway commission. A State county road and bridge committee, elected by the county board or appointed by its chairman, is empowered to purchase and sell county road machinery, to enter into road and bridge contracts in the name of the county, to generally direct the expenditures of all road funds, and to see that all arrangements for the construction and maintenance of highways and bridges provided by the county board are properly carried out.

After improvement, State roads and bridges are maintained by the counties.

Local Road Legislation

The county board of each county elects a county highway commissioner. Upon the first election, he serves one year; upon

the second and succeeding elections, two years. The county highway commissioner is in charge of all construction and maintenance work, except that the county committee acts as a board of directors jointly with the State highway commission in the general control and conduct of the work in each county.

General jurisdiction over all roads other than those on the State system in each town is in the hands of town boards, consisting of three members elected annually. The method of paying the road taxes is determined by statute. The poll tax is included in the tax roll and levied against all males within the legal age limits. The cash system of payment of road taxes prevails in most counties.

Local Bond Legislation

Any county, through its board, may issue nontaxable coupon bonds bearing interest at 5 per cent, payable semiannually, for the original improvement of any portion of the system of prospective State highways. The bonds may run not to exceed ten years, and the entire issue, when added to other county indebtedness, must not exceed 5 per cent of taxable property, as ascertained by last assessment. The bonds may not be sold below par outside of the county until the residents of the county have had a reasonable opportunity to purchase them, and when sold, the proceeds must be apportioned to the respective towns by the county board. The form of the bonds is to be approved by the State highway commission, and the bonds are to be printed from plates furnished by the commission.

The bonds are to be divided as to denominations and due dates so as to have an equal amount payable each year. The interest and principal are provided for by a direct tax to be assessed by the county board. Provision is also made for the issuance of bonds conditioned upon the payment of all interest by private subscriptions, but money or approved securities must be first deposited to secure the payment of this interest. State aid may be obtained upon proceeds from bond sales not to exceed one-half of the tax levy in the county for the payment of the face of the bonds.

No bond issue shall be authorized for more than one-fifth of 1 per cent of the assessed value of all the taxable property in the county until the proposition has been submitted to a vote of electors of the county, and a majority of those voting have been favorable. A petition signed by qualified electors equal to 10 per cent of the number of votes cast for governor at the last general election may secure the submission to a vote of any proposition to issue bonds.

Any town may issue bonds for the original improvement of any portion of the system of prospective State highways in a manner similar to that of the county, except that the proposition must, without exception, be submitted to a vote of the qualified electors of the town at a regular town meeting, or at a special meeting called for the purpose. The rate of interest and other terms of the bonds are practically identical with those of the county.

Convict Labor

The law provides that convicts in county jails may be used in quarrying stone for road work. The law also provides that convicts in the State prison may be used in the construction of roads. The employment of convicts on State roads is optional with the counties. A number of the counties may use convicts for their work in 1916.

Automobile Registration

The law provides for annual registration with the secretary of State. The schedule of fees is as follows: Motor cycle, \$2; all other motor vehicles, \$5; dealers and manufacturers, for each garage, \$10.

Three-fourths of the net registration revenue is returned to the county from which collected at the end of each year, to be expended in repairing highways outside of incorporated towns and cities. The remaining amount is credited to the State highway fund in the State treasury.

Highway Officials

Wisconsin Highway Commission, Madison.—J. A. Hazelwood, chairman, Jefferson; W. O. Hotchkiss, State geologist, Madison (ex-officio); F. E. Turneure, Madison (ex-officio); John S. Owen, Eau Claire; J. H. Van Doren, Birnamwood.

A. R. Hirst, State highway engineer; M. W. Torkelson, bridge engineer; William Dawson, chief clerk.

Road Funds

The State-aid law was passed by the legislature in 1911, and at that time an annual appropriation of \$350,000 was made. This did not prove enough to meet the State's full one-third, as proposed by law, as 511 towns voted a total of \$422,163 for road improvement, and 125 towns voted a total of \$55,133 for bridge improvements.

In 1912 the amount available for State-aid was \$350,000 plus \$28,000, the latter amount being 25 per cent of the net proceeds of

the automobile fund of the State. It was seen, however, that \$378,000 was totally inadequate to meet the demands of the towns, which asked for \$830,000. When the legislature met in January, 1913, they made an additional appropriation to meet the demands of the towns. There was, therefore, available for 1913 work, \$2,500,000 in round numbers.

There was available for construction in 1914 the sum of \$4,330,000 made up of a State appropriation of \$1,230,000 and town and county appropriations of \$3,100,000. Appropriations for 1915, including balances of about \$300,000 carried over, and \$3,670,000 appropriated by State, counties and towns, amounted to \$4,000,000.

For 1916, the amounts available from the towns, counties, and State amount to about \$3,600,000 in round numbers.

The appropriation for the support of the commission in 1916-17 is \$65,000. The counties now pay the actual cost of surveys made by the commission for them, which was formerly a charge against the appropriation for the commission.

Progress Report

There are 75,887 miles of road in Wisconsin, which has 2,500,000 population, nearly 2,000,000 living in rural districts. A 9-foot road has proved most economical for local conditions. The miles of road improvements carried out to the close of 1915 are as follows:

YEAR	GRADING	NON-PERMANENT	CRUSHED STONE MACADAM	CRUSHED GRAVEL MACADAM	PIT RUN GRAVEL	CONCRETE	MISC. TYPES
1912	448.99	2.08	158.85	56.86		6.28	15.36
1913	888.14	17.74	216.73	129.73		25.52	42.43
1914	1219.65	51.26	330.20	82.92	130.92	52.23	47.58
1915*	1225.00	850.00	230.00	110.00	180.00	66.00	65.00
Total*.....	3781.78	921.08	985.78	379.64	310.92	150.03	170.37

* Figures for 1915 construction are taken from the preliminary reports and are approximate only.

*The number of miles graded represents the total number of miles graded and surfaced (3,781).

Publications

State Geological and Natural History Survey

Road pamphlet, 1907.

Bulletin 10 (Economic Series 6). Highway construction. 1903.

Bulletin 18 (Economic Series 11). Rural highways of Wisconsin. W. O. Hotchkiss. 1906.

Road Pamphlet 1. Earth roads. A. R. Hirst. 1907 and 1909.

- Road Pamphlet 2. Earth road drag. A. R. Hirst.
Road Pamphlet 3. Stone and gravel roads. A. R. Hirst.
Road Pamphlet 4. Culverts and bridges. A. R. Hirst.
Road Pamphlet 5. First biennial report of the Highway Division.
State Agricultural Experiment Station
Report for 1902. Road construction in Wisconsin.
Report for 1903. Road construction and maintenance.
Bulletin 79, 1899. Road construction and maintenance.
State Highway Commission
Bulletin 1. The new State highway law, chapter 337, Laws 1911.
Bulletin 2. Instructions to county highway commissioners and foreman for building State aid roads.
Bulletin 3. The amended State highway law, chapter 668, laws 1913.
First preliminary biennial report, 1912.
Bulletin 4. Revision for 1914 work of Bulletin 2.
Bulletin 5. State highway law as amended in 1915.

[Approved by WILLIAM DAWSON,
Chief Clerk, State Highway Commission.]

WYOMING

State Aid Legislation

Certain highways, 2600 miles, have been designated as public highways to be improved by State convicts, under the control of the State commission of prison labor. All locations and surveys of such highways are to be made under the direction of the State engineer, while the county commissioners are required to secure rights of way and construct bridges in connection with plans made by the State engineer. Appropriations of \$17,500 have been made for equipment for convict labor work. About 100 miles of road have been thus improved. No State money aid is granted.

Local Road Laws

The county commissioners have charge of roads. Each county is divided into road districts, and a supervisor is elected for each district, who is under the direction of the county commissioners.

Local Bond Legislation

The State constitution authorizes the county and subdivisions thereof to create indebtedness not to exceed 2 per cent of their taxable valuation, but there has been no statutory enactment, either general or special, under the authority thus conferred, for the issuance of road bonds.

Convict Labor Laws

Any convict may be put to work on roads and streets.

Automobile Registration

The law provides for annual registration of automobiles with the secretary of State. The registration fee is \$5.

Four dollars of each registration fee paid is returned to the county treasurer of the county from which received, and shall be credited to a special fund for expenditure only for temporary improvement of the county roads. The remaining one dollar of such registration fee is retained by the secretary of State for the payment of expenses incident to such registration. (Chapter No. 95, Laws 1913.)

Progress Report

There are about 15,000 miles of county roads in the State and several thousand miles of roads to which the counties pay no attention. Over 1000 miles of road in hilly and mountainous sections have been graded and drained.

Road Funds

In addition to four-fifths of the automobile license fees, various sums are received from inheritance taxes, road poll taxes, proceeds of the U. S. Forest Reserve fund and general county taxes. From 30 to 35 per cent of the total tax proceeds is spent on roads, including bridges. It is estimated that about \$305,000 will be available for road work in 1916.

[Approved by JAMES B. TRUE, State Engineer.]

HIGHWAY IMPROVEMENT IN CANADA*

In the Dominion of Canada there are about 250,000 miles of graded roads. Road-building is a slow process, and in most countries it has taken half a century at least to provide adequate surface construction. The immediate objective in Canada should be to substantially improve about 16 per cent of the total, or 40,000 miles, which would carry the more concentrated market or farm traffic; while about 2 per cent additional, or 5,000 miles should be treated on a trunk road basis. The total cost might be approximately estimated at \$250,000,000, of which about \$50,000,000 has been spent.

The following brief outlines of road administration in the various provinces of the Dominion, contain only sufficient of the essential facts in each case to indicate the general situation.

*By Hon. W. A. McLean, Deputy Minister of Highways of Ontario, Toronto, Ont.

From these it will be observed that no two provinces have the same organization. The same is true of the various American states, and of all countries in the world. This great variety of organization is due to the variety of local circumstances, which have influenced the general trend of public feeling, action and administration on which road organization is based. Thus the mountainous character of British Columbia has prevented uniform municipal organization such as is possible in the prairie provinces. The French code and French characteristics of Quebec have made a striking difference as compared with Ontario; in the former, a more paternal system is acceptable, while in the latter case, local self-government is more congenial to the spirit of the people.

British Columbia

Road mileage, 12,500.

Road-building in British Columbia has been almost entirely a provincial work, due largely to the mountainous and heavily timbered character of the country.

Under the department of public works, the general system has been to have a competent engineer as deputy minister, and under him, experienced road superintendents for each of the 29 electoral districts. The superintendents employ foremen and laborers; and details in each district are largely left to the judgment of the road superintendent.

Provincial estimates for roads and bridges in 1901 amounted to \$344,000; in 1915 estimates amounted to \$2,459,000. A special program was provided about 1910, with an estimated outlay of about \$20,000,000, the greater part of which has been spent in the construction of main roads.

Climatic conditions in British Columbia in some respects resemble the ordinary conditions of Canada, but on the Coast, there are roads which can be used the year around, which have no rest by snow protection, and which suffer in the winter by heavy rains.

Alberta

Little attempt is made in the Province to construct surfaced roads, owing to the absence of suitable road-making material. The roads are, therefore, merely earth-graded roads, with not always continuity of grading. It is possible and customary on these prairie roads to pass over those portions where the soil in its natural state will carry traffic, and to first make passable those portions on which grading, drainage or other improvement is most urgent.

Expenditure is made on roads by the rural municipalities and local improvement districts; also by the provincial department of public works, under the engineer of highways.

Municipal expenditure in 1913 was \$681,000; in 1914, \$865,190; and in 1915, about \$900,000.

Provincial expenditure is devoted largely to trunk road improvement, while the municipalities seek to improve the outlying branches.

The Provincial government in 1915 spent approximately as follows: Trunk roads and bridges, \$500,000; maintenance of trunk roads (also for improvement of minor roads not in trunk road districts), \$200,000; bridge construction not on the trunk road system, \$230,000; ferry services (66 in the Province), \$70,000; total, \$1,000,000.

The province recognizes in general two classes of trunk roads: First, those paralleling railway lines which are dealt with by the Province, both as regards construction and maintenance; and second, those leading out from shipping or business centers, at right angles to railway lines, and toward which an endeavor is made to obtain the co-operation of rural municipalities and local improvement districts. Local organizations, however, use their funds chiefly on roads leading traffic to the provincial trunk road system.

Saskatchewan

Road improvement is largely carried on by the Province under a board of highway commissioners, but with increasing settlement, rural municipalities and local improvement districts have been formed. Whereas roads were formerly maintained entirely by the provincial government, municipal organization is steadily adding its force to the betterment of roads.

The duties of the provincial commission are as follows;

1. To lay out, plan and determine upon a system of public highways for the province, which may from time to time be altered or modified as the board may determine.
2. To determine upon the most feasible and economical methods for constructing, improving and maintaining public highways.
3. To furnish the officers of the municipalities with information respecting the construction, improvement and maintenance of public highways.
4. To appoint such engineers, inspectors and officers as are necessary for the proper carrying out of the duties of the board and the provisions of the act.

The board endeavors to devote the most of its expenditure to main roads, but also assists or constructs minor roads and bridges not on main roads, which, for special reasons, are beyond the

ability of the local municipality to build. The board also assists local municipalities to the extent of 50 per cent of the cost of improvements, when these improvements have been carried out in accordance with the regulations of the board.

The use of the road drag is encouraged with good results; ferries are operated; while all bridges of over 20 feet span are built by the commission. In 1914, about 2300 miles of road were kept in repair by use of the drag.

For 1915, the provincial appropriations were as follows: Roads and bridges (from revenue), \$500,000; steel bridges on concrete foundations (bond issue), \$300,000; highway construction (bond issue), \$1,200,000; total, \$2,000,000.

Owing to conditions created by the war, the amounts actually expended were approximately as follows: Roads and bridges (revenue), \$170,000; steel bridges (bond issue), \$63,000; highway construction (bond issue), \$328,000; total, \$661,000.

As with Alberta, metalled roads do not exist outside the cities and towns. At the present stage of development, little can be attempted other than to attend to the worst places, so that, though the Province may undertake in any year to complete a certain mileage of roads, the actual work consists in grading such parts of the road as are impassable, because crossed by coulees, sloughs, or other obstacles. Thus in a given stretch of prairie road, possibly only 10 per cent of the distance actually receives attention.

Manitoba

Road mileage, 31,000.

The provincial government maintains a road department under a provincial highway commissioner, while municipal organization is active. The Province is divided into 100 rural municipalities with population varying from 600 to 5000 in each. The municipal council (controlling local expenditure) consists of a reeve and four or six councillors, half of whom are elected for one year, and the remainder for two years. Municipal organization is very similar to that of Ontario.

The expenditure in the Province in 1915 was as follows: Municipal expenditure alone, about, \$700,000; under good roads act, \$374,790; total, \$1,074,799.

The former expenditure has been made solely under the direction of the municipal councils. It would be difficult to approximate the real value of this work or to give an idea of what it stood for in constructed road mileage. In very few instances is there a well-defined policy or system being followed. The work performed is more in the way of repairs, constructing small structures, and relieving the more emergent and pressing conditions in the different municipalities.

The expenditure under the good roads act is made under the direction of engineers of the provincial department and in conformity with well-defined systems within the municipalities operating under the act. Towards the expenditure of \$374,790 for the season of 1915, the provincial government contributed \$141,700.

The general features of the Manitoba good roads act are as follows:

1. The council must initiate the scheme of improvement.
2. Council must then submit the system to the good roads board of the province, by resolution of the council.
3. The scheme is then examined and reported on to the board by one of the engineers of the department.
4. If the board approves, the scheme is recommended to the lieutenant governor by the minister of public works.
5. If it is finally approved there, the secretary-treasurer of the municipality is notified.
6. The council submit to the rate-payers a by-law to which their assent must be obtained. The vote of the people is required in each and every case. They vote that these roads will be the main roads of the Province.
7. After assent of rate-payers is received, the scheme may go ahead and receive the prescribed assistance under the act. For an earth road this is one-third of cost; for a gravel road or any more permanent form of road than earth, one half the cost.

Ontario

Road mileage, 55,000.

The Province of Ontario has a department of public highways in charge of a deputy minister, chief engineer and staff, with a considerable range of duties, both educational and constructional. It has been announced that the collection of motor vehicles licenses will be made a branch of the highways department, and a revenue of \$500,000 is anticipated for 1916.

Of the total road mileage (55,000 miles) about 20,000 miles are merely well-graded earth roads; about 22,000 miles have been more or less satisfactorily surfaced with gravel or stone; while the remainder, 13,000 miles, are little used and unimproved.

Southern Ontario is the most densely occupied portion of Canada where, in an area of about 40,000 square miles, there is a population of about 2,500,000, one-half of which is urban and the other half rural. In the southern and populous portion, which is chiefly agricultural, there is an annual municipal expenditure on roads in the open country of about 1,100,000 days statute labor and \$2,000,000 in cash, annually; while the Province spends about \$1,500,000 annually through three channels viz.:

1. Subsidies to leading market and main roads in southern Ontario.

2. A special appropriation of \$5,000,000 on trunk colonization roads in northern Ontario.

3. Minor colonization roads in northern Ontario.

Owing to the strong claims of agricultural communities, the assistance given by the provincial government to the better class of construction in southern Ontario has been largely confined to subsidizing the leading market roads in each county.

Ontario has both township and county organization. Township councils are elected annually, and the reeve of each township (town and village) is, ex-officio, a member of the county council. Township councils, primarily, have control of all the roads, but a county council is authorized to take over from the townships the leading roads of the county for construction and maintenance. To this system of county roads, the provincial government has heretofore paid one-third of the construction cost only, but under legislation of 1915 will hereafter contribute 40 per cent of the cost of construction, and 20 per cent of the cost of maintenance. More than half of the counties are operating under this plan with good results, and to the present time, a total of over \$6,000,000 has been spent on the work. It is anticipated that, under the increased subsidy, the remainder of the Province will adopt county systems in a very short time.

Under new legislation for main roads, more attention will be given to the development of certain trunk lines, for which there is a growing demand.

A main road is interpreted as one running directly between two important terminal points or cities, and passing through a series of municipalities. Such series of municipalities may petition the highways department for construction as a main road; and if the petition is endorsed by three-quarters of the municipalities affected, the department will make surveys, prepare specifications and appoint a special board of commissioners to take charge of the construction and maintenance of the road. The cost in the engineer's report is apportioned among the municipalities benefited (the government contributing 40 per cent); and the commissioners then act as a court of revision to hear the appeal of any parties affected as to the engineer's apportionment of the cost. The commission may confirm or revise the engineer's report, and unless a majority of the municipalities then petition against the work, the commission is authorized to proceed with construction.

It will thus be seen that, in the Province of Ontario, a three-fold classification, very desirable in road organization, is being evolved in the following manner:

1. Main or trunk roads to be constructed and maintained by special commissioners under the guidance of the provincial highway department; the cost to be met by provincial subsidy and direct assessment on cities and rural municipalities benefited.
2. Leading market roads, to be under the control of county councils, subject to regulations and inspection of the provincial authorities; the cost to be met by provincial subsidy and county levy on all assessable property within the county, including cities.
3. Local feeders, to be under the control of township councils, and at the expense of the township.

New Brunswick

Road mileage, 14,000.

The province is divided into 15 counties, these being subdivided into 144 parishes. Under an Act of 1908, the performance of statute labor in each parish is governed by a highway board, consisting of two elected county councillors, and a secretary-treasurer appointed by the provincial government.

Provincial government expenditure, under the minister of public works and a highways engineer, in 1915, amounted to \$179,919.57. In allocating this appropriation, a certain amount is granted to each county, then the members of the legislature representing the counties, sub-divide them into districts, and in each district a road supervisor is appointed. The road supervisor is again allotted a certain proportion of the amount granted to the county. The expenditures are made under this supervisor, and sworn returns in detail are furnished to the public works department, when individual cheques issue to cover.

Nova Scotia

Road mileage, 18,000.

The rural part of the Province has county organizations, 18 in all. In 1880 the municipalities had full control of the roads and bridges but neglected them, and the provincial government enacted various laws; first taking over the construction of the larger bridges; then the maintenance of larger bridges; then the construction and repair of smaller bridges; and finally the maintenance of highways to a great extent.

In 1908, a provincial commissioner of highways was appointed, an office under the commissioner of public works.

Expenditure under the provincial highway commission in 1915 was approximately as follows: For highway structures of permanent material out of capital (not included with larger bridges), \$216,668; for construction and maintenance of highways including smaller bridges, out of capital, \$82,117; for construction

of larger bridges out of capital, \$82,537; total, out of capital, \$381,922. For construction and maintenance of highways, including smaller structures and repairs to larger bridges, out of revenue, \$252,129. Total expenditure, \$634,051.

The total amount of revenue for the last fiscal year from automobile licenses was \$21,270, and is set apart specifically for road purposes. An amount of about \$250,000 is assessed annually by the municipalities under the Statute Labor Law, and the expenditure is under the control of the county authorities.

In carrying on the work of the provincial department, counties are separated into districts for provincial highway expenditure, and over each district is placed a provincial inspector, there being 39 inspectors in all. It is the duty of each inspector to send to the provincial highway commissioner, yearly, a report of road improvement required, with an estimate of the cost. When such report and estimate have been approved by the provincial department, it is the duty of the inspector to organize and carry on the work and to return pay rolls to the provincial department.

The Province up to the present has very little but earth roads.

Prince Edward Island

Road mileage, 3,800.

The Province is not divided into municipalities, and all the roads are maintained directly by the provincial department of public works.

The Province is divided into 38 road divisions, with an average of about 100 miles of road in each.

Each division is supplied with a road machine and a man to run it, the division being presided over by a road inspector, who has charge of all work in his division. The soil of the Province is of a soft, loamy nature, and about 90 per cent of the roads are merely earth roads, maintained by road machinery. There is practically no macadamizing or permanent work.

The total amount expended on roads in this Province is about \$30,000 per annum, equal to about \$8 per mile.

*Quebec**

In the Province of Quebec, local municipalities, according to the municipal code, look after the making and maintenance of roads. This does not mean that all the roads of the municipalities are built and maintained directly by the local council.

*Contributed by Hon. B. Michaud, Deputy Minister of Highways of the province of Quebec, Montreal, P. Q.

Practically, it is the contrary that exists. Excepting certain municipalities in the eastern townships, roads in local municipalities are maintained by each land owner, and are subject only to a general supervision by the council (in certain exceptional cases, the county councils build or maintain certain roads).

The government of the Province of Quebec, though anxious to improve the system of road maintenance, has respected the autonomy of local municipalities and has taken no coercive action thereon, but, in order to induce the local municipalities to give up the system of maintenance by the land owner, it has, in 1908, decided to grant an annual subsidy to local municipalities taking at their own charge the maintenance of their roads. Up to 1915, out of the 1100 municipalities of the Province, 300 or 400 have taken the government's offer.

As far back as 1908, the government has granted subsidies equal to \$1000 a year for macadam and \$500 a year for gravel, in the proportion of 50 per cent of the amount expended by each municipality. Besides, one-half of the amount expended for the operation of the machinery was paid.

In 1912, without giving up the system of the 50 per cent grant, the government got authorization from the legislature to borrow \$10,000,000 and to give to the local municipalities allocations sufficient to cover the whole cost of the work done by them in gravel or in macadam.

Out of the \$10,000,000 above mentioned, the government has carried out two plans: *First*—It has allocated, as already said, certain sums to local municipalities for macadamizing or graveling. *Second*—It has employed a certain part of the \$10,000,000 for the building of trunk roads between important centers of the Province.

Most of the gravel and macadamized roads built in the Province of Quebec has been constructed between 1908 and 1915. The work referred to in this paragraph is macadam and gravel roads constructed according to the government's specifications and regularly inspected by it.

The Department of Roads owns 57 complete outfits for the construction of macadam. These outfits are lent or rented to the municipalities.

Besides the government's outfits, about 150 outfits are owned by municipalities. They have been paid with the money allotted by the government to those municipalities out of the \$10,000,000 referred to above.

From 1908 to 1915 910.8 miles of macadam have been constructed under the government's supervision and with its aid; also 416.45 miles have been gravelled under the same conditions.

MILEAGE OF IMPROVED AND UNIMPROVED ROADS

Approximate estimate, subject to correction

(Prepared in the U. S. Office of Public Roads and Rural Engineering)

STATE	TOTAL MILEAGE	TOTAL MILEAGE SURFACED
Alabama.....	49,639	5,591
Arizona.....	5,987	455
Arkansas.....	36,445	1,385
California.....	48,089	9,888
Colorado.....	30,571	855
Connecticut.....	14,061	3,138
Delaware.....	3,735	281
Florida.....	17,954	2,875
Georgia.....	99,607	13,507
Idaho.....	18,406	811
Illinois.....	94,141	9,300
Indiana.....	63,370	27,031
Iowa.....	112,496	640
Kansas.....	111,536	1,175
Kentucky.....	58,000	10,836
Louisiana.....	24,962	797
Maine.....	25,528	3,514
Maryland.....	17,025	3,056
Massachusetts.....	23,031*	11,963*
Michigan.....	74,192	8,585
Minnesota.....	92,314	7,033
Mississippi.....	44,072	1,900
Missouri.....	120,000	8,200
Montana.....	23,319	150
Nebraska.....	80,338	275
Nevada.....	12,751	75
New Hampshire.....	15,116	1,165
New Jersey.....	14,817	4,640
New Mexico.....	16,920	975
New York.....	80,112	23,198
North Carolina.....	51,612	6,849
North Dakota.....	61,593	200
Ohio.....	83,681	28,512
Oklahoma.....	71,325	500
Oregon.....	42,930	4,095
Pennsylvania.....	87,387	4,326
Rhode Island.....	2,169	2,169
South Carolina.....	45,787	5,188
South Dakota.....	56,354	315
Tennessee.....	45,913	5,704
Texas.....	128,971	10,790
Utah.....	7,970	1,728
Vermont.....	15,082	3,478
Virginia.....	43,399	5,282
Washington.....	42,526	5,252
West Virginia.....	31,629	1,173
Wisconsin.....	75,706	14,100
Wyoming.....	10,569	475
Total.....	2,333,117	262,366

*Includes town and village streets. Estimated total rural mileage 17,272, of which about 9,000 miles are surfaced.

PART II

Historical Notes

Technical Details of Road Construction and Maintenance European Road Systems

HISTORY OF ROAD BUILDING

Ancient Road Builders

When or where the first road was built is not known. Herodotus speaks of a great Egyptian road on which King Cheops employed 100,000 men for a period of ten years. According to the historian, this road was built of massive stone blocks 10 feet deep, and lined on both sides with temples, mausoleums, porticoes and statues. The streets of Babylon are said to have been paved as early as 2000 B.C., and several well surfaced roads radiated to neighboring cities. Carthage, before its fall, was the center of a highly developed road system. The ancient Peruvians had a wonderful system of national roads connecting all the principal parts of their empire.

Bridges were also built by the ancients at a very early date. The Euphrates, at Babylon, was crossed by a stone bridge prior to 2000 B.C., and it is known that the Chinese built bridges as public works as early as 2900 B.C.

The Romans as Road Builders

The first definite and fully authentic information concerning the systematic construction and maintenance of permanent roads comes to us from the Romans. It is generally understood that the Romans learned the art of road building from the Carthaginians. However, the construction of their first great road was as perfect as that of any of their later ones.

The first of the great Roman roads was from Rome to Capua, a distance of 142 Italian miles, and was begun by Appius Claudius, about 312 B.C. It was known as the Appian Way or "Queen of Roads." This road was later extended to Brundisium, a total of 360 miles, and was probably completed by Julius Cæsar. About 220 B.C. the Flaminian Way was built. It crossed the river Nar on a stone bridge which had a central span of 150 feet with a rise of 100 feet. When Rome reached the height of her glory, under the reign of Augustus, no less than 29 great military roads radiated from the city. These roads extended to every part of the vast empire and are estimated to have had a total length of 50,000 miles.

The Roman construction was in general extremely massive. The Appian Way is said to have been in good repair 800 years after

it was built. On a carefully prepared earth subgrade was placed four successive courses or layers; the statumen or foundation course, the rudus or second course, the nucleus or third course, and the pavimentum or wearing surface. The top and bottom courses consisted in general of large flat stones, while the two intervening courses were built of smaller stone or other suitable material laid in lime mortar.

With the fall of the Roman Empire the roads were neglected and gradually fell into decay, so that today but little more than a trace remains of these splendid achievements.

The French as Road Builders

The Romans built and improved many roads throughout what is now France, but later these fell into decay. It was not until the beginning of the seventeenth century that interest in road building revived to any considerable extent. In 1661 Colbert was appointed comptroller of finance, and during his ministry 15,000 miles of hard road were built by means of enforced peasant labor under the old feudal institution of the corvée. The corvée prevailed with the utmost rigor until 1774, when Turgot abolished some of its most objectionable features. It was finally abolished in 1787.

The present road system of France was really founded by Napoleon. He adopted very largely the innovations instituted by Tresaguet, and perfected a splendid administrative system.

The most striking feature of the French road system is the skilled supervision provided in every grade of road work and in every unit of the administrative organization. The basis of the French system is the School of Roads and Bridges, one of the finest technical schools in the world, and maintained entirely at the expense of the National government. From the graduates of this school are chosen the highway engineers who are entrusted with the construction and maintenance of the roads of France.

The total mileage of all roads in France is about 519,148 miles. Of these 23,756 miles are classed as national roads and are, therefore, the property of the State. The remaining roads are divided into departmental and vincinal routes, for which the state only makes occasional appropriations for construction and which are invariably maintained by the local governments.

Toll Roads

The earliest mention we have of the exaction of tolls is probably that given by Strabo, on the roads leading from Babylon to Syria. It is not until 1346 that we find the toll system definitely adopted

as a means of raising revenue for road maintenance and repair. In that year Edward III of England granted a commission to the Master of the Hospital of St. Giles and John Holborn to collect tolls on vehicles passing on the road leading from the Hospital of St. Giles to the Old Temple, London, and also on an adjoining road called the Portal. But it was not until the latter half of the eighteenth century and first part of the nineteenth century that this method of raising road revenues reached its greatest popularity. This took the form of a regular flood of turnpike acts passed by Parliament. It is estimated that in 1838 no less than 1100 turnpike trusts were in existence throughout the kingdom. The cost of collecting the tolls, however, often nearly equaled the income, leaving little or nothing for maintenance. In 1871 the census showed that 5000 persons in England and Scotland were engaged in merely collecting tolls. In 1857 Ireland freed herself from toll gates, and in 1878 Parliament passed an act abolishing tolls in England.

Tolls on vehicles were never popular in France and while introduced somewhat at different periods, never became general.

In the United States the first toll road was the Lancaster Pike, between Philadelphia and Lancaster, Pennsylvania, a distance of 62½ miles, the construction of which was authorized in 1792. Bridges were also constructed by private capital and tolls charged for crossing. The turnpike improvements continued to expand rapidly until in 1828 the length of chartered turnpikes in Pennsylvania amounted to 3110 miles, of which 2380 miles were completed at a cost of \$8,431,059.50. It is stated that none of these roads had, up to that time, yielded sufficient dividends to remunerate their proprietors. By 1811 over 317 turnpikes had been chartered in New York and the New England States, having a combined length of 4500 miles and a capital of over \$7,500,000. With the introduction of the railroad, interest in turnpike building practically ceased, and today there remain in the United States very few roads on which toll is collected on passing traffic.

The Cumberland Road.—Popular tradition generally attributes the conception of the National Road to Henry Clay. However, Albert Gallatin seems to have made the first definite suggestion of this road, while Henry Clay soon became its ablest champion.

By an act of Congress approved by President Jefferson on March 29, 1806, \$30,000 was appropriated toward the survey and construction of a road leading from a point on the Potomac at or near Cumberland, Maryland, to the Ohio River at or near a point opposite the town of Steubenville. This act provided that the road be cleared to a width of four rods, and that no grade exceed five degrees. An act of Congress, May 15, 1820, provided \$10,000 for laying out a road from Wheeling, Virginia, to the Mississippi

River near St. Louis. This was really to be a continuation of the Cumberland or National Road. The road was to be laid out 80 feet wide.

In 1835 arrangements were completed whereby the portion of the National Road between Cumberland and Wheeling was taken over by the respective States and operated as a toll road. Appropriations, however, were continued on the portion west of the Ohio River until May 25, 1838, when the last direct appropriation for construction was made. The total amount appropriated by Congress was \$6,824,919.33.

The length of the line first opened was 130 miles and the cost of construction \$1,700,000. The first stage coach bearing the United States mail from Cumberland to Wheeling passed over the road on August 1, 1818.

West of the Ohio, the road led through Columbus, Indianapolis and Terre Haute. The road was surfaced to Columbus, but west of that point it was only surfaced in places; and about 1850 most of the road was absorbed by local turnpike companies. Before the road was completed beyond the western boundary of the State of Indiana, the steam railway had become the chief agency of transportation and the National Road came to an end on the prairies of Illinois.

Great Road Builders

Tresaguet.—Pierre-Marie Tresaguet was born at Nevers, in 1716, died in Paris, 1796. While he was a great engineer and made many improvements for river navigation, posterity knows him only as a great road builder. Tresaguet may well be called the father of modern road building. In 1775, when MacAdam was but twenty-one years of age, Tresaguet presented a report to the Assembly of Bridges and Highways which amounted in reality to a treatise on road construction. The real value of Tresaguet's work was; first, in recognizing the need of constant maintenance and devising a means for carrying it out; second, improving the methods of construction and reducing the cost. The prevailing form of stone roads up to this time consisted of a transversely level stone pavement on which was placed broken stone to the depth of 12 inches at the sides and 18 inches at the middle. Tresaguet improved the drainage, gave a crown to the stone pavement or foundation, and reduced the depth of broken stone to a uniform thickness of 10 inches. The roads built by Tresaguet differ but little from those built by Telford in Scotland some thirty years later. While Tresaguet was not fortunate enough to leave his name to the type of road he advocated and built, he laid the foundation upon which it was possible for Napoleon to build the

great system of French highways. Tresaguet laid especial emphasis on organized, continuous maintenance. He first began the organization of cantonniers, which are the very backbone of the present French system of road maintenance.

John Loudon MacAdam.—John Loudon MacAdam was born at Ayr, Scotland, September 21, 1756, and died November 26, 1836.

While MacAdam was not the inventor of the road which now bears his name, he nevertheless deserves great credit for the work he did. The broken stone road as adopted by MacAdam was used in practically the same form in several parts of Europe, though he was no doubt the first to grasp and fully explain the theory of the broken stone road without a paved foundation.

MacAdam demonstrated that stone when broken to the proper size and placed on a properly drained and graded earth foundation would so consolidate under traffic as to be thoroughly waterproof and capable of carrying the heaviest vehicles without injury. He held that the earth, in fact, sustained the load, and all that was necessary was to thoroughly drain the roadbed and protect the surface with an impervious covering.

At the death of his father in 1770, young MacAdam went to live with his uncle, a merchant in New York City. In 1783 he returned to Scotland and was shortly appointed as deputy-lieutenant for the county of Ayreshire. In performing his duties as magistrate and trustee of roads, MacAdam became impressed with the lack of scientific principles in the construction and maintenance of the roads. In 1816, he became inspector for the Bristol "Turnpike Trust" and supervised the reconstruction and repair of 178 miles of roads. In 1817 he built the first macadam roads in London, the approaches to Blackfriars and Westminster bridges. In 1823 MacAdam moved to London, where he was appointed street commissioner in 1817. Slowly the system of construction and maintenance which he advocated spread throughout the entire empire. In 1836 he returned to Scotland where he owned a house in the little town of Moffat: but he was not long permitted to enjoy his leisure, for he died the same year.

His principal writings are: *A Practical Essay on the Scientific Repair and Preservation of Public Roads*, London, 1819, and, *Remarks on Present State of Road Making*, London, 1820.

Thomas Telford.—Thomas Telford was born in Dumfriesshire, Scotland, August 9, 1757, and died September 2, 1834, and was buried in Westminster Abbey.

Thomas Telford was one of the greatest civil engineers of his time. He was one of the founders of the "Institution of Civil Engineer" and was annually elected as its president until his death. His works were recognized both at home and abroad. For the Austrian government, he built the road from Warsaw, to

Brest, while the King of Sweden conferred the order of knighthood of "Gustavus Vasa" in recognition of his services on the Gotha Canal. As some of his most notable achievements may be mentioned the following bridges: Across the Tay at Dunkeld, the Menai Straits, the Conway bridge, the Deanbridge at Edinburgh, and the Broomielaw bridge at Glasgow. Canals: Ellesmere, Caledonian, Gloucester and Berkeley, Grand Trunk, Macclesfield, Birmingham and Liverpool Junction, and the Gotha. Harbors: Pulteneytown, Aberdeen, Dundee, Dover, and the St. Katherine docks at London.

In 1803 he was appointed engineer for the construction of 920 miles of roads in the highlands of Scotland. Later, he perfected the road communication between London and Scotland and the northern towns of England. An undertaking of equal magnitude and importance with that in the highlands of Scotland was a system of roads through the more inaccessible parts of Wales.

The form of construction most generally used by Telford, and which bears his name, is very similar to that employed much earlier by Tresaguet. The foundation course on which is placed the broken stone consists of stones about 10 inches by 6 inches by 4 inches, in dimension, carefully placed by hand and keyed firmly with smaller chips. Care is taken to secure the best possible drainage. At the present time, the Telford system is more commonly employed abroad than in this country. American road builders usually only resort to the Telford system when the natural earth foundation is weak. The chief objection is generally stated as being the high first cost due to the large amount of hand labor required.

Principal Inventions

The Steam Road Roller.—The steam road roller was invented by M. Louis Lemoine, of Bordeaux, France, and a patent was granted to him by the French government in 1859. M. Lemoine's roller was first used on the road in the Bois de Boulogne in 1860. The first English patent was granted to Messrs. Clark and Batho in 1863. About 1864 a roller built under this patent was shipped to Calcutta, where it was used with great success.

The first steam roller used in England was on the roads in Hyde Park in 1866. In September 1867, the borough authorities of Liverpool purchased from Messrs. Aveling and Porter their first steam road roller, which weighed 30 tons.

The first steam roller used in the United States was imported from England in the fall of 1868. This roller was first used in the United States Arsenal grounds, Philadelphia, Pennsylvania. At the present time, the term "steam roller" is somewhat of a

misnomer, as the recent developments in oil and gasoline engines have made this form of motive power practical.

The Stone Crusher.—The stone crusher was invented in 1858, by Mr. Eli Whitney Blake, of New Haven, Connecticut. Mr. Blake's crusher was used for the first time in Central Park in crushing stone for concrete. In 1859 the city of Hartford, Connecticut, purchased one of these crushers for use in the improvement of its streets and roads. This is the first application of mechanical power in the preparation of road metal.

Mr. Eli Whitney Blake was born in Westboro, Massachusetts, on the 17th of January, 1795. He was a nephew of Eli Whitney, the inventor of the cotton gin. In 1816 he graduated from Yale. For a time he studied law, but soon entered the manufacturing business. He died in 1886.

ROAD SYSTEMS OF FOREIGN COUNTRIES

Austria-Hungary

The roads in Austria-Hungary are divided into four administrative classes, namely; government roads, provincial roads (designated county roads in Hungary), district roads, and town roads (designated parish roads in Hungary). The government roads, of which there are 10,008 miles in Austria and 5600 in Hungary, are constructed and maintained at the expense of the imperial government, which has complete supervision over construction and maintenance. The provincial roads in Austria, of which there are 2288 miles, and county roads in Hungary, of which there are 17,400 miles, are constructed and maintained at the expense of the province or county, the imperial government contributing in some cases. The district roads, of which there are 39,212 miles in Austria and 8100 miles in Hungary, are constructed and maintained by the districts, except that very poor districts are aided by the province or the county. The town roads, of which there are 22,756 miles in Austria, and the parish roads, of which there are 700 miles in Hungary, are local roads and are paid for by the town or parish, the province or county occasionally aiding by grants. The total mileage of all roads in Austria was 74,265 miles in 1909, and in Hungary 31,800 miles in 1910. The average cost of maintenance in Austria is given at about \$311 per mile per annum, and in Hungary \$282, exclusive of bridges. In both Austria and Hungary the general government has general supervision over all roads. In Austria the road administration is under the ministry of the interior, under which there are district engineers, each in charge of 74½ miles of road. Under each of the district engineers are three road masters, each having about 24.9 miles of road, and these in turn supervise the actual road workers or patrolmen, each of whom has about 2.9 miles of road to maintain. There are in all about 4000 men employed on the Austrian government roads. The Hungarian road system is similar and employs about 2500 men.

Denmark

The roads of Denmark are divided into main roads, of which there were 4213 miles in 1910, and local roads, of which there were 22,505 miles in 1910, or a total of 26,718 miles. The main roads are maintained at the expense of the counties, of which there are

twenty-one in the kingdom, and the local roads are maintained at the expense of the parishes, which are sub-divisions of the counties. There is a general superintendent of highways who has supervision over all the highways in the kingdom. The direct supervision, however, is by the counties for main roads, and by parishes for local roads. The government does not grant money aid. The principal roads in the kingdom are maintained by a patrol system, under which each patrolman has charge of about $2\frac{1}{2}$ miles of road. The cost of construction varies widely, ranging from about \$1300 to about \$8700 per mile, the character of construction being usually either gravel or macadam.

England and Wales

There were in 1909-10 a total of 150,908 miles of roads. The roads are divided into main roads and roads other than main roads, the mileage in 1909-10 being respectively 27,826 miles and 123,082 miles. The general government renders aid to road construction and maintenance in three ways; first, through the assignment of certain national revenues, varying in amount, to the aid of local taxation, it being optional with the local authorities as to how much of this fund is spent on roads; second, by loans through the government road board; third, by free grants through the government road board. The government does not supervise the work where it is done with current revenues, but where it is under loan or grant, the sanction of the road board must be obtained and this is generally based on plans and estimates. The assistance granted by the government through loans and grants is for the construction and maintenance of new roads or the road board itself may construct and maintain new roads. The annual cost of maintenance of main roads is given for 1909-10 as \$389 per mile per annum. and the roads other than main roads \$112 per mile per annum. The amount expended by local authorities in 1909-10 was \$32,498,000, not including loans, which amounted to \$7,916,964.

France

The roads of France aggregate 519,148 miles and are divided into the following classes: national roads 23,756 miles; department roads 8,161 miles; vicinal roads, sub-divided into roads of through travel 107,049 miles, and roads of common interest 47,256 miles (the roads of these two latter classes traversing several communes or towns), ordinary vicinal, which are located within a single commune, 177,550 miles; rural roads, which are unimportant neighborhood roads 155,376 miles. It is estimated that the national roads cost \$12,400 per mile for construction and \$285 per

annum for maintenance; the department roads \$7750 per mile for construction and \$166 per annum for maintenance; the vicinal roads of through travel \$6200 per mile for construction and \$121 per annum for maintenance; the vicinal roads of common interest \$3750 per mile for construction and \$102 per annum for maintenance; the ordinary vicinal roads \$2470 per mile for construction and \$49 per annum for maintenance. The national roads are constructed and maintained entirely at the expense of the national government, which also aids by subsidies to a small extent, the vicinal roads. The departments maintain the department roads. The national government has general jurisdiction over all transportation facilities and direct supervision over the national roads, which are administered by the corps of bridges and roads in the ministry of public works. The corps of bridges and roads is divided into three divisions, of which roads and navigation form one.

The division of roads and navigation is under the direction of a counselor of state and is divided into two sections, namely; bridges and roads, and navigation. The section of bridges and roads is divided into two bureaus, one of which has entire charge of the national roads, and the other has jurisdiction over all matters relating to department roads, automobile traffic and general police regulation. The sections and bureaus and the higher field inspection are under the direction of inspectors general. Each of the inspectors general of the second class have charge of a large field division and under him engineers in chief, usually one to each department, while under these engineers in chief are ordinary engineers and under them are sub-engineers and conductors or foremen and finally the patrolmen who work directly and constantly on maintenance, each having a section of road varying in length, but averaging about 2.8 miles. There were 8560 patrolmen employed in 1909 on the national roads. The engineers for the French road service are trained in the School of Roads and Bridges at Paris and are appointed upon graduation to the lower positions and gradually advanced to positions of responsibility.

The annual expenditure on the public roads of France is about \$48,000,000. The national government appropriated in 1910, \$9,720,000 for the national roads. It is estimated that the total cost of the entire French road system, excluding the unimportant neighborhood roads, is upwards of \$1,663,000,000.

Germany

The imperial government of the German Empire takes no part in the construction or maintenance of public roads. Each state in the Empire follows its own policy in this matter.

As a general rule the roads in the various states are divided into

three classes: state or provincial roads; county roads, and local roads. The state roads are generally built and maintained by the state, which maintains a corps of competent engineers. The larger states usually divide their road systems into districts, the engineers in charge of the districts reporting directly to the central office. The patrol system is quite generally followed, each patrolman having from 2 to 5 miles of road to maintain. Their compensation is from \$150 to \$250 per annum. At the end of thirty years service, or if sooner incapacitated, they are entitled to a pension.

Prussia takes no direct part, however, in the maintenance of roads. The state roads were turned over to the provinces in 1875 and some of the provinces in turn passed them on to the counties. The general government grants aid to the provinces by certain allowances from the "donation fund."

The largest class of improved roads in the German Empire is that of the county roads which are very largely maintained by local taxation. The states and provinces, however, exercise close supervision over these roads. The parish roads are purely local and are maintained and managed by the parishes, although occasionally the county and even the province aid in new construction.

There are approximately 36,000 miles of state road in Germany, of which Prussia has 20,489 miles, Bavaria 4200 miles, Saxony 2267 miles, Baden 1890 miles, Württemberg 1710 miles, and the smaller states the remainder. Of county roads Prussia has 38,400 miles hard surfaced, parish roads 14,598 miles hard surfaced, and private roads 1100 miles hard surfaced, or a total of 74,587 miles of improved roads, or 1 mile for each 1.8 square mile of area. Prussia expends nearly \$35,000,000 a year on all roads, of which about 28 per cent is paid by the provinces, 33 per cent by the counties and 39 per cent by the parishes. Under favorable conditions the cost of construction of state roads does not often exceed \$5000 per mile. In Hannover a considerable mileage of brick roads has been constructed at from \$10,000 to \$13,000 per mile. In the kingdom of Württemberg the cost of maintenance of state roads in 1910 was \$400 per mile.

Italy

The roads of Italy aggregated 92,199 miles in 1910, and were divided into three classes, namely, national roads, connecting important cities and ports; connecting with roads of other countries; the Alpine and Apennine roads, and those used for military purposes, having a total mileage in 1910 of 5159 miles; the provincial roads, connecting the chief town of each province with the chief towns of other provinces and with maritime ports, having a total of 27,757 miles; communal roads, which are the roads of local interest, having a mileage of 59,283 miles. The national roads are

constructed and maintained by the national government through the department of public works. The official in charge is designated as the director general of bridges and roads. The provincial roads are constructed and maintained by the provinces, while the communes or townships provide for the construction and maintenance of communal roads. The national roads are maintained by means of the patrol system, each patrolman having an average of $2\frac{1}{2}$ miles of road. It is estimated that the cost of maintenance in 1909-10 was \$274.70 per mile per annum for national roads, and \$183.32 per mile per annum for provincial roads.

Norway

The roads of Norway aggregate 17,550 miles and consist of main roads, 6570 miles, and district roads, 10,980 miles. The national government contributes two-thirds to three-quarters of the cost of construction of main roads, while the maintenance of such roads is, with few exceptions, a local burden. The work is done under county engineers who are nominated by county councils and appointed by the national government. At the head of the whole system, however, is the national road director. It is estimated that the main roads cost about \$8000 per mile.

Russia

There are 11,254 miles of post roads in Russia, of which 8326 miles are under direct government control and 2928 miles are temporarily under control of district councils with government supervision. The construction and maintenance of these government roads are partly under the ministry of ways and communications, and partly under the war department. It is estimated that the cost of construction of government roads is from \$8544 to \$10,874 per mile, and the maintenance from \$70 to \$210 per mile per annum.

Spain

There were 33,873 miles of road in Spain, in 1910, which were classified as state roads and provincial roads. State roads are constructed and maintained by the general government through the department of public works. Under this department is a director general, and under him a chief engineer for each province. The government also aids, by appropriations, maintenance of provincial roads. The patrol system is followed in the maintenance of state roads. It is estimated that the maintenance of state roads costs between \$230 and \$240 per mile per annum.

Sweden

There were 35,450 miles of road in Sweden, in 1907, made up of 11,850 miles of main roads and 23,600 miles of district roads. The main roads are those which unite the kingdom with other countries and connect the large cities and ports. The district roads are those of local importance. For the construction of main highways, the government pays two-thirds and the districts one-third of the cost, while on maintenance of these roads, the government pays 15 per cent of the total. The royal board of road building and water works has supervisory powers in road, railroad and harbor construction. The expenditure per mile of road, including all classes, was in 1907, \$60 per mile.

Switzerland

There were in 1911, 7426 miles of road in Switzerland which were classified as federal aid canton roads built and maintained by the cantons with federal aid, 350 miles; canton roads, built and maintained by cantons, 862 miles; municipal roads built and maintained by municipalities 6214 miles. The federal government grants aid only to those four cantons whose roads are of international character, the annual aid being as follows: Uri, \$15,440; Graubunden, \$38,600; Tessin, \$38,600; Valais, \$9650.

The department of public works in each canton supervises road construction and maintenance, while the upper supervision of the federal government is carried on through the department of the interior. Construction of roads in Switzerland is very expensive on account of the fact that they are practically all mountain roads.

TYPES OF ROADS

Earth Roads

The importance of earth roads is indicated by the fact that of the approximate mileage of 2,200,000 in the United States, 2,000,000 are classed as earth roads. The work in the future upon earth roads should contemplate (1) proper drainage, (2) reduction of grades, (3) improvement of alignment, (4) betterment of the road surface.

Proper Drainage.—The prevailing defect in earth roads is poor drainage and this defect is the first one which should be remedied. Drainage is for two purposes, first to remove water which reaches the surface of the road by precipitation or otherwise and, second, to remove under ground water which reaches the road from adjacent land or through the top surface. Surface drainage is accomplished by securing a reasonably firm crowned traveled roadway and by providing broad shallow ditches of good alignment and uniform grades and with ample outlets. Subdrainage to remove water from beneath the road surface or to prevent its presence in the roadbed is accomplished most effectively by so-called blind drainage or French drains or special sub-side-drains. There are also other methods. These methods include center subdrains or V-shaped drains or sometimes rock bottoming in the form of a rough telford construction. The best side-drains consist of a trench $3\frac{1}{2}$ feet deep, 15 inches wide at the top, in which is laid an open bell joint glazed tile 4 to 6 inches in diameter with the bells up hill and the trench back filled with broken stone or coarse gravel. The main purpose of these drains is to intercept ground water. The joints of the pipes should be left open and the drains should lead into a proper outlet so that the water may go entirely away from the road. One such drain upon the up-hill side of a road will frequently remedy the worst conditions due to the presence of water. The V-drain consists of a shallow V-shaped trench under the entire traveled way which is back filled with field stones or cobbles. Such construction requires considerable excavation but is somewhat cheaper than two side-drains. The excavation must be 12 to 18 inches deep at the center and 6 to 8 inches deep at the edges. It should be back filled with stones ranging from 6 to 10 inches in diameter with the largest in the bottom. To dispose of water collected by this drain, trenches should be dug about every 50 feet and back

filled with stone. These trenches should lead entirely away from the road so it is seen that this construction is mainly available for either roads located over fills on boggy land or on side-hills when the outlets will of course be on the down hill side only. Sub-drainage should not be undertaken without proper lines and grades furnished by an engineer as it is expensive and if properly put in would constitute sufficient drainage for any subsequent improvement of the road by macadamizing or otherwise.

Returning to the matter of surface drainage, the earth road should be kept free from ruts by the use of the road drag or otherwise and a crown of 1 inch to the foot should be preserved. Water is thus shed toward the sides. The side ditches collect surface water and must be kept free. On heavy grades they will tend to wash and may require paving in the worst cases. The wash may usually be prevented by providing sufficient outlets to reduce the volume of water. A common defect in earth roads is failure to provide side-drains to discharge water away from the roads. Surface drainage is greatly hampered and interfered with by drive-ways leading into private grounds. Raised drive-ways across open gutters divert the water into the center of the road and unfortunately in most instances where tiled drains have been placed, they have become broken or clogged and every considerable rain storm threatens the destruction of a portion of the roadway. The only point where such a drive-way is safe is at the top of a grade. Even when drive-ways are provided with under drains it is common to find that the drainage of the drive-way itself runs into the road. Surface drainage then upon earth roads demands fearless treatment of the drive-way problem. It would probably pay in most instances to pave the bottom of the gutter where the drive-way crosses it and leave the side drainage free.

When it becomes necessary that drainage water cross the road, ample culverts must be provided. The worst fault common to culverts is that they rapidly become clogged with leaves or other rubbish. They should therefore be of more than sufficient size in the first instance. When less than from 2 to 3 feet of earth cover tile pipe, it is liable to become broken. The prevalent defect on earth road construction in the matter of culverts is that they are too small and too near the surface. It will pay even in earth road construction to install more expensive culverts in the first instance rather than to rip them up for repairs at frequent intervals.

Grade and Alignment.—The worst grade on any road is the effective limitation of traffic. After a grade exceeds a rise of 6 feet in the hundred it is serious. Grades may be avoided or reduced either by relocation in part or by excavation and embankment. The best treatment of earth roads in the matter of grades is to

establish once and for all a definite, permanent grade with the engineer's level. It need not follow that the entire road is to be graded but with the grade line in mind the worst hills may be cut down and the worst hollows filled up and year by year the entire road will progress toward a final and satisfactory profile. Much money has been wasted by not adopting such a grade line at the outset. In the matter of relocation it is, of course, impossible for a road well established in the community to be entirely changed or abolished in most cases. Grade improvement may have to be brought about by relocating smaller portions of earth roads. Here, again, the services of a surveyor or experienced road supervisor with a transit will prove economical in the end. Some necessary relocation may be undertaken each year. In reducing grades or relocating for earth roads, it is not necessary that all cuts and fills should balance as excess of material may always be used to widen fills and a deficiency of material can usually be supplied by widening the cuts. In the matter of roads over rocks or ledges, it is cheaper to fill up hollows with borrowed earth than to undertake excessive rock cutting. In constructing or repairing an earth road, it is quite common to use the scraping grader or road machine. Where work with this machine is undertaken the width of the road between gutters should be determined. It is a common fault to find earth roads too wide. Twenty-four feet between gutter lines is ample for a road which a community is not warranted in improving by macadamizing or otherwise hardening its surface. Frequently 20 or 18 feet is a sufficient width. With the width between gutters in mind, a line of stakes should be set before the grader begins its work. The line of stakes along each gutter will improve the work of the grader and leave gutters which will not tend to cause wash into the road.

Surface Betterment.—When it is desired to spread new material upon an earth road care should be taken to secure it from the best available supply. It is not good practice to place gravel in patches upon an earth road to fill hollows. Materials should be spread uniformly upon the traveled way and should be applied for a considerable distance and the ends of the application should be reduced in depth gradually so as not to form a new chuck hole. The object of the scraping grader is to simultaneously construct gutters or side-drains and place material for a crown in the center.

Right here is opportunity for a great improvement in earth road work. Sod, leaves, vegetable matter and rotted material of any description can never form a road surface. There are two ways of using the grader. It may be operated at first to cut the surface only and scrape all perishable material into ridges which are later carted away or the grader may be run regardless of sod and other poor material and men with rakes and forks can then

follow it and remove all objectionable matter into dump wagons. Old roads are frequently in such condition that it is better to scrape the shoulders and gutters away from the center and remove the entire mass. Frequently this operation alone will result in a well established and crowned roadway with live material for its surface.

Conclusion.—The earth road problem today is a problem of repair and maintenance. No earth road will endure travel without constant care. The use of the split-log drag which is described in the paragraph upon maintenance is the best method for preserving road surfaces and establishing proper surface drainage from the traveled way to the side ditches. Earth road repairs will become unnecessary in proportion to the increased care in road maintenance. It cannot, however, be expected to start any maintenance upon an earth road until it is put in reasonable repair. The repair should follow the lines indicated above, that is to say, earth road repair should include some permanent drainage work, the reduction of some of the worst grades, the straightening of bad curves and the betterment of the road surface by the removal of worn out and objectionable material.

Sand-Clay Roads

A sand-clay road is composed of sand and clay mixed in such proportions as to form a compact and firm support to traffic. The perfect sand-clay road should be neither sticky nor sandy. The sand and clay may form a natural mixture, in which case the road is termed a "natural sand-clay road." The two materials may have become mixed in the fields along the road by successive cultivation of soil, and this soil known as "top soil" is sometimes used in road construction.

There are many varieties of both sand and clay, consequently there is a wide variation in the characteristics of a sand-clay road. Sand while one of the hardest minerals known, possesses practically no binding or cementing power. The grains of sand instead of cohering in a tough mass under the impact of traffic and the action of water, remain loose and shifting. No road is so difficult to travel as the road located through fine sand, and the difficulties are enormously increased when high winds prevail.

Clay is a decomposition product of the mineral feldspar. If the clay has been carried by water the deposit is known as "sedimentary clay." If the feldspathic rock has disintegrated in place, the product is known as "residual clay." The sedimentary clays are in general more sticky and plastic than the residual clays. In contrast with sand, which possesses no binding power but is very hard, clay is a powerful binder, but does not possess the quality of hardness. It is evident that in the construction of a sand-clay

road the sand must furnish the quality of hardness and resistance to wear while the clay must furnish the quality of toughness and bind the individual sand grains firmly together.

The theory of the sand-clay road is very similar to the theory of the macadam road. In the latter, rock dust and screenings fill the voids between the angular fragments of stone and when wet serve as a cement or binder. The grains of sand may be likened to the angular fragments of stone and clay to the rock dust binder. In the most successful sand-clay road, just a sufficient amount of clay is used to fill the voids between the grains of sand. In this way, the sand sustains the wear, while the clay serves as a binder. If too much sand is used, the result will be loose sand on the surface; if too much clay is used, the surface of the road will become sticky after rains.

The best mixture of sand and clay can be made when the materials are wet, and particularly is this true of the "ball clays." The more water that is used, the better the mixture, and if practicable, the materials should be puddled. A disk harrow may be used to advantage.

The extent to which the mixing can be carried on will depend largely upon the character of the clay. If it is a very plastic clay, much greater effort will be necessary to obtain a complete mixture; if, on the other hand, it is a slaking clay, the mixing will be much less difficult. Slaking clays are not as satisfactory, however, as the ball clay, as their binding powers are much less. In selecting clay for road purposes, it is always best to select the stickiest clay available. A common test is to wet the thumb and place it against a piece of clay. If the clay sticks to the thumb, it is reasonable to suppose that it will stick to the sand; if it will not stick to the thumb, it is safe to assume that it will be a poor binder in a sand-clay road.

If the clay is placed on sand to a depth of 6 inches, a cubic yard of clay will cover 54 square feet, consequently a 16-foot road treated in this manner would require about 1 cubic yard of clay for each 3 feet of length. A mile of 16-foot road would, therefore, require 1760 cubic yards of clay. The amount that can be hauled by the average team varies from two-thirds to 1 cubic yard, according to the character of the road over which the hauling is done.

If the clay sub-soil is to be treated with sand, it should be plowed and harrowed to a depth of about 4 inches. On this prepared sub-surface should be placed from 6 to 8 inches of clean sand, spread thickest at the center and sloping to the sides in much the same manner as the clay is applied to a sand road. These materials should then be mixed dry instead of the wet mixing, which is preferable when clay is applied to sand. This is preferable, because the clay can be better pulverized when in a dry state. After the

dry mixing, the road should be heavily sprinkled or should be puddled after the first heavy rain. After the materials are thoroughly mixed and puddled, a road machine or grader should be used to give proper crown to the road, and if a roller is available the road can be improved by the use of it. As it is impossible to determine exactly the proportions of sand and clay to be used in the first place, it is necessary to give careful attention to the sand-clay road for a considerable time after it is completed, in order that additional sand or clay may be applied as needed.

Gravel Roads

There are three important qualities which should be possessed by road-building gravel—hardness, toughness, and cementing or binding power. Of these three qualities, the last is the most important. This binding quality is due in part to the presence of oxide of iron, lime, or clay, and in part to the angular shape and size of the pebbles composing the gravel. Blue gravel is generally conceded to be the best for road construction, because it is usually derived from trap rock. As the pebbles composing the gravel retain the characteristics which they formerly possessed as a part of the larger rock itself, it follows that as trap rock is considered an excellent material for road building, trap rock gravel should occupy the same relative rank among the gravels. Quartz possesses practically no binding power, although it is very hard. Therefore, gravel which contains an exceptionally large percentage of quartz will not prove successful, as it will fail to consolidate unless it contains binding material, or unless a good binder is added. This, however, is not true of the chert gravels which bind and consolidate very well forming excellent roads.

The shape and size of the pebbles composing the gravel have an important bearing upon its value as a road material. In order that the material may bond readily, the pebbles should be angular and should vary in size so that the smaller fragments may fill the voids between the larger pieces. Gravel obtained from streams is usually inferior to pit gravel for the reason that the action of the water has worn the pebbles smooth and practically all the fine binding material has been removed by the same agency. Even if clay or loam is mixed with river or creek gravel, the result is not likely to be as satisfactory as that obtained by the use of pit gravel. Pit gravel frequently contains too much clay or earthy matter, while river gravel may have too much sand. In such cases it is advisable to screen the gravel so as to eliminate the material which is too fine and that which is too coarse. The screen should be similar to that which is used in preparing material for a macadam road. In the handling of the gravel care should be exercised not

to separate the binding material from it, nor should this binding material be allowed to settle to the bottom in spreading the material over the road surface. It will often be found advisable to spread a thin layer of such binding material over the surface after the material has been distributed and rolled, and after this the surface should be sprinkled and rolled again, or else rolled while still damp from the rains.

When the gravel, especially that which is to constitute the surface layer, contains large pebbles, these should be removed and either thrown aside or else raked into the foundation or recrushed. At least 60 per cent by weight of the gravel should be pebbles above one-eighth inch in size, and there should be no pebbles in the bottom layer that will not pass through a 2½-inch or 3-inch ring, and in the top layer there should be no pebbles which will not pass through a 1½-inch ring. Not over 20 per cent of the mass should be clay, and this should be uniformly mixed and should contain no large lumps. Ten or 15 per cent of clay produces better results than 20 per cent. If the foundation or road bed is loose, it should be carefully rolled. It is quite as important to have a solid foundation for a gravel road as for a macadam road. Gravel will compact to about 80 per cent of its depth, loose measure. If the compacted depth of the gravel road is to be 8 inches and the width 12 feet, it will take about 2250 cubic yards of gravel to the mile, and it is best to make the first layer about 6 inches in depth, loose measure, and the second layer about 4 inches in depth, loose measure.

Gravel should not be dumped directly on the road, as this will usually result in a rough, uneven surface. A carefully staked out sub-grade or "box" with earth shoulders is necessary. The sub-grade should be rolled. If specially devised spreading wagons are not used, the gravel should be dumped on boards and spread from them on to the road. The gravel should be placed on the road commencing at the end nearest the gravel pit in order that the teams may aid in packing the material.

Each layer of gravel should be rolled separately with a power roller; the rolling should begin at the sides and continue toward the center until the surface is thoroughly compacted. The surface layer should be sprinkled while the rolling is in progress, but if a roller and sprinkler are not available, the road should be constructed during the wet season of the year, as the rains will cause the material to pack much better than if the road were built during the dry season.

The split-log drag, or some similar device, can be used to advantage in maintaining gravel roads but it will be necessary to use hand rakes to remove excessively large stones which appear on the surface. New gravel must be uniformly spread from time to time.

Macadam Roads

The macadam road takes its name from John L. MacAdam, whose biography appears on page 189. The word *macadam* denotes a surfacing composed of angular broken stone bound together, whose voids are filled with stone screenings flushed with water, and which is consolidated by rolling, into a practically impervious crust, superposed on a thoroughly compacted foundation or subgrade. Both the exposed surface and the subgrade have a crown or slope from center to sides.

A good macadam road should have (1) proper location, (2) easy grades, (3) perfect drainage, (4) firm subgrade or foundation, (5) broken stone with good wearing and bonding properties and (6) careful inspection during the construction. Proper location and easy grades are more essential for macadam roads than for less expensive types of roads for the reason that unless right at the outset they cannot be changed without extraordinary expense.

Perfect Drainage.—Drainage must remove water from the road surface and the foundation and carry it entirely away from the road. The properly completed macadam surface sheds water into broad open side ditches by virtue of the road crown. The side ditches may have to be paved upon steep grades especially where they carry considerable water from adjacent land. When ditch water must cross the road, catch basins are usually necessary and ample culverts should be provided of first class construction (see article on page 232). To drain the road foundation or subsoil, side-drains with tiled pipe and stone back fill are most effective. Where considerable field stone is present a shallow so-called V-drain forming the entire subgrade is cheaper than two side-drains and equally effective in providing sub-drainage. The V-drain filled with stone not greater than from 8 to 10 inches in diameter with the larger stones at the bottom, should be brought to the true crown and rolled and it should have frequent outlets entirely away from the road. When properly built, the V-drain offers an excellent foundation for the macadam surface. In particularly damp or boggy spots a telford foundation or bottoming course of hand laid stone not less than 6 inches in depth is sometimes used. Modern practice, however, seems to favor either the sub-side-drain or the V-drain construction for drainage purposes. Sub-drainage is usually required in heavy cuts on hillside roads and for roads over swampy land.

Subgrade.—After a road has been properly graded and the permanent drainage structures completed, the subgrade must be built. In cuts through firm soil, the subgrade is formed by simply excavating a trench of width and depth equal to the width and depth of the compacted stone surfacing. Spongy material wherever

encountered must be removed and replaced by good live earth or gravel. Where loose dry sand is encountered, the utmost care is necessary to prevent the sand from churning into the first layer of broken stone when rolling commences. In fills if the earth has been deposited in layers and subjected to teaming, the subgrade trench or box may be excavated and afterwards thoroughly rolled. Care must be taken to insure that the subgrade is thoroughly solid and it must not wave under the roller. Material excavated from the subgrade is piled along the sides or shoulders to form earth abutments to prevent spreading of the macadam when it is rolled. Too much care and refinement cannot be given to the subgrade or foundation for the macadam. It should invariably be rolled to a true firm surface, clean and without ruts and with perfect crown. There will then be no waste of stone or churning of earth into the lower course to weaken the macadam and the tendency of the finished road to form holes will be largely avoided.

Broken Stone.—Trap rock is the best road stone for plain macadam or "waterbound" macadam construction. It is frequently desirable, however, to use local stone and the Office of Public Roads, U. S. Department of Agriculture, will test stone samples from any locality in this country free of charge. This Office has published complete tables showing the relative merits of nearly all road stones. Road stone should (1) be hard enough to wear well, (2) so tough that the roller does not crush it, (3) and possess bonding qualities to form a smooth unyielding surface. Road stone is usually placed in two courses; the first course ordinarily consists of stones varying in size from 3 to 1½ inches in greatest diameter. The softer stones may be somewhat larger than the denser or tougher material. Ordinarily a roller cannot compact more than 6 inches of loose stone successfully and it is customary for the first course to be rolled separately. The stone is spread either from spreader wagons or from dumping boards. Careless dumping of the stone directly upon the subgrade in piles will result in an uneven finished surface. The first course is sometimes called the No. 1 stone. It is thoroughly rolled with a steam roller until walking does not loosen the stones. Teams hauling stone over the subgrade should guard against cutting ruts or churning the stone into the subgrade soil. Upon the rolled first course, a second course of stone varying in size from 1½ to ¾ inches in diameter is placed to a depth of about 3 to 5 inches in a manner similar to the first course. When the second course stone has been rolled until its surface is smooth and the individual stones are well keyed together and no creeping or wavering appear before the front wheel of the roller, the bonding process commences.

Careful Inspection.—Bonding of a macadam road is accomplished by completely filling the voids in the broken stone with fines or

screenings from the crusher. The process of binding or bonding requires the greatest care. The fines or screenings or stone dust should be worked into the road *gradually*. To accomplish this, the screenings are spread in thin successive courses with alternate wetting by a sprinkling wagon and continuous rolling. Care should be taken that wagons drawing screenings should not cut up the partially built road. When the voids are completely filled mud will flush to the surface in front of the roller and the bonding is complete. If the macadam is well bonded, the road is now strong enough to withstand the kick of a boot-heel.

The width and depth of macadamized surfaces are governed by local conditions. A one-way road may be as narrow as 8 feet. The general practice is to build macadam surface from 14 to 16 feet in width. The thickness of the macadam surface is determined somewhat by the traffic conditions and varies from 5 to 8 inches when complete. Loose broken stone is usually estimated to consolidate from one-fourth to one-third under rolling.

A newly built or green macadam road will sometimes immediately show tendency to ravel particularly if the second course stone is trap rock. This raveling usually cures itself but if it continued, removal of the larger loose stones and additional rolling may be necessary.

Qualities of Macadam Road Material

"Uniform specifications for crushed stone for macadam construction are in a measure impracticable, owing to the necessity of meeting local conditions in the selection of the stone. The table on page 210, showing maximum and minimum results of tests made by the U.S. Office of Public Roads on rock samples, embracing a large number of specimens of stone from various sections of the country, will afford the engineer an intelligent idea as to the standards to which stone should conform in order to be usable."

Bituminous Macadam Roads

The term "bituminous macadam"¹ was introduced about the year 1906 to designate a macadam road, for which some form of bituminous material was used as a binding agent and to form a

¹In justice to those who claim that the term "Bituminous Macadam" should be used in a much more restricted sense the following definition from the Report of the Sub-Committee on Bituminous Paving Nomenclature of the American Society of Municipal Improvements is given.

(3) Bituminous macadam is a pavement consisting principally of crushed stone and retains its integrity of structure mainly by the mutual support of the various particles of stone, aided by the slight bonding value of the fine mineral matter in its composition, and which is protected from surface dis-

surface coat. The desirability of changing from the original type of what is now called "waterbound macadam" was brought about unquestionably by the action of increasing automobile traffic. When the presence of automobiles of various types and speeds became general on macadam roads, it was found (1) that more or less dust was raised from the surface by the passing automobile and that this dust usually was carried away from the road; (2) that the surface of the dry macadam road soon raveled and in the worst conditions completely disintegrated; (3) that it was too expensive to water macadam roads sufficiently to prevent the formation of dust and the consequent destructive effect of excessive automobile traffic.

A bituminous macadam road does not differ from the original macadam construction until the process of binding begins. It has been found, however, that the former desirable qualities in road stones, such as hardness, toughness, and cementing qualities, do not play so important a rôle as formerly when the stone in question is to be treated with bituminous material. If we assume then the construction of a macadam road to have progressed through the stages of proper drainage, grading and consolidation of the subgrade, we then place the first course of No. 1 stone upon the rolled subgrade, as formerly. This No. 1 stone is still laid in the same standard sizes ranging from $2\frac{1}{4}$ to $1\frac{1}{2}$ inches in diameter. After this course has been thoroughly rolled to consolidated thickness, say from 3 to 5 inches, the No. 2 course is then applied. There are two well defined methods for applying this course.

Mixing Method.—No. 2 stone varying in diameter from $1\frac{1}{4}$ to $\frac{1}{2}$ inch is mixed with sufficient quantity of bituminous material to thoroughly coat all the pieces. This may be done by hand labor upon a mixing board, or by machinery. The practice of using mixing machines similar to concrete mixers is increasing and with the better types of machines results are satisfactory and the cost is reduced. Practice has shown that it requires in the

turbances by an upper bonding layer of bituminous material. It is a one-layer pavement and there is no definite distinction to be made between the wearing surface and the base, as in their nature they must be knit together in one structure. Practically all the horizontal stability, as well as vertical support, is from the macadam base. The pavement may be produced by adding the bituminous top to the macadam base by either the penetration method or the mixing method. In the former the bitumen is applied in a liquid state and a top dressing of stone or sand is spread over the surface and thoroughly rolled. In the latter the bitumen is mixed with the mineral, consisting of comparatively fine stone or sand, or a mixture of both, and forced into the macadam body of the pavement by rolling. In either case, whether the penetration or mixing method is followed, the macadam base must be specially prepared, with voids in the upper portion into which the bitumen or bituminous mixture penetrates leaving a coating of the desired thickness over the surface.

neighborhood of $1\frac{1}{2}$ gallons of bituminous material per square yard of finished surface, so that if a second course were spread 3 inches thick loose, a cubic yard of stone would require about 18 gallons of bituminous material. After the coated stone has been put in place, a thin layer of clean, sharp fines (from which the best practice demands the removal of the dust) is spread lightly and the course is then rolled with a steam roller. Whenever an excess of bitumen appears on the surface, more fines should be added and rolled. After rolling is completed, all surplus fines and dust should be swept from the surface. A seal coat or paint coat or finishing coat of bituminous material to insure waterproofing and complete filling of the voids is now applied. This consists of a uniform application of about one-half gallon to the square yard of surface. Screenings or fines are again applied and the road may or may not be rolled.

Penetration Method.—By the penetration method, the second or No. 2 course of stone is put in place and partly rolled with a steam roller. The bituminous material is then applied either by hand from pouring pots or by some modified hose nozzle leading from a tank cart or by a mechanical distributor. Material for hand spreading is usually brought to the job in barrels; when a tank cart is used, it is generally filled from a tank car at the siding. Bituminous material is heated usually by steam from a steam roller, but when hand pots are used, the material is heated with kettles over fires. The application is about $1\frac{1}{2}$ gallons to the square yard and the object is to penetrate the second course to a considerable depth. It is now considered good practice to apply the bituminous material under pressure from a hose fitted with a proper nozzle to spread the material in a finely subdivided stream, or spray. The object is to secure better penetration and more uniform distribution over the road stones. After the distribution of bituminous material, a light coating of sharp, clean fines or screenings or sometimes sand or clean gravel is applied and rolling progresses. A paint coat of about one-half gallon to the square yard is usually applied, followed by a coat of screenings to complete the construction.

The above description presents a bold outline of bituminous construction and it must be understood that various modifications in processes are practiced, e.g., the No. 1 course may be bound with screenings or No. 2 course may also be partly bound with screenings, even with the use of a sprinkler and subsequent drying of the road. Some engineers prefer to apply the stone without screening into separate sizes with the object of securing the reduction of the voids by the use of crusher run stone. Other engineers have seen fit to use No. 1 stone as the second course. It is clearly evident that the final standardization of bituminous construction

Maximum and Minimum Results on Rock Samples, Corrected to January 1, 1914

NO. OF OF SAM- PLS	NAME	SPECIFIC GRAVITY			WEIGHT—POUNDS PER CUBIC FOOT			WATER AB- SORBED— POUNDS PER CUBIC FOOT			PER CENT OF WEAR			FRICTION CO- EFFICIENT OF WEAR			HARDNESS			TOUGH- NESS			ORIENTING VALUE			NAME
		Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	
23	Amphibolite.....	3.15	2.75	3.02	196	172	189	1.65	0.04	10.3	1.5	41.7	3.9	19.0	13.5	40	7	235	3	Amphibolite.						
66	Andesite.....	2.95	1.85	2.66	184	115	166	12.50	0.05	17.4	1.4	28.6	2.3	19.4	5.0	44	5	500	9	Andesite.						
208	Basalt.....	3.15	2.30	2.85	193	143	178	6.40	0.02	16.6	1.3	30.4	2.4	19.3	5.7	47	5	500	2	Basalt.						
64	Chert.....	3.00	2.00	2.65	187	125	156	11.10	0.25	29.2	2.7	14.9	1.4	19.7	12.7	26	5	500	2	Chert.						
12	Conglomerate.....	2.75	2.50	2.60	172	156	162	3.31	0.36	26.8	3.5	11.6	1.5	18.4	9.3	10	10	500	4	Conglomerate						
276	Dabase.....	3.20	2.65	2.94	200	165	185	2.73	0.04	6.3	1.1	36.4	6.4	19.4	12.3	54	4	500	2	Dabase.						
84	Diorite.....	3.35	2.70	2.87	209	168	179	1.03	0.05	12.0	1.7	23.8	3.3	19.4	16.6	38	4	164	5	Diorite.						
304	Dolomite.....	3.00	2.30	2.72	187	143	173	9.40	0.07	22.5	1.3	33.3	1.8	18.8	1.8	37	2	179	8	Dolomite.						
13	Ecdogite.....	3.70	2.95	3.15	231	184	196	0.28	0.05	2.9	1.8	22.7	13.8	18.8	17.4	31	14	130	10	Ecdogite.						
443	Epidoite.....	3.30	2.70	3.00	206	168	187	1.65	0.23	7.4	2.0	19.6	5.4	19.5	10.7	29	13	83	3	Epidoite.						
13	Felsite.....	2.85	2.50	2.65	175	156	165	3.13	0.03	3.4	1.9	21.3	11.8	13.7	13.7	16	16	101	2	Felsite.						
91	Feldstone.....	3.65	2.75	2.97	228	172	195	2.63	0.04	6.9	1.3	30.8	6.8	13.8	13.3	23	6	134	6	Feldstone.						
48	Gabbro.....	3.20	2.60	2.76	200	162	172	1.23	0.03	16.4	1.7	29.0	2.4	19.3	9.0	26	2	209	1	Gabbro.						
209	Gneiss.....	3.00	2.00	2.66	187	125	166	3.00	0.04	24.6	1.1	37.0	1.6	19.6	13.6	33	3	245	2	Gneiss.						
260	Granite.....	2.85	2.00	2.67	175	125	160	13.22	0.02	34.2	1.8	21.7	1.2	19.2	0.0	25	2	500	3	Granite.						
247	Gravel.....	2.90	2.65	2.77	181	165	173	2.19	0.06	37.0	2.3	17.5	1.5	17.3	4.5	23	2	85	9	Gravel.						
954	Limestone.....	3.65	2.65	2.95	231	165	184	1.03	0.27	6.3	3.0	13.2	7.6	15.0	13.3	13	9	91	25	Limestone.						
63	Marble.....	3.15	2.35	2.69	196	147	174	2.65	0.04	7.6	1.6	24.5	5.3	19.7	15.3	53	4	200	0	Marble.						
15	Mixed stone.....	2.90	2.00	2.66	187	125	166	3.00	0.04	24.6	1.1	37.0	1.6	19.6	13.6	33	3	245	2	Mixed stone						
5	Peridotite.....	3.65	2.65	2.95	231	165	184	1.03	0.27	6.3	3.0	13.2	7.6	15.0	13.3	13	9	91	25	Peridotite.						
126	Quartzite.....	3.15	2.35	2.69	196	147	174	2.65	0.04	7.6	1.6	24.5	5.3	19.7	15.3	53	4	200	0	Quartzite.						
45	Rhyolite.....	2.90	2.05	2.66	181	128	160	7.15	0.03	9.7	1.7	24.1	4.1	19.7	15.3	43	6	500	5	Rhyolite.						
442	Sandstone.....	3.25	1.90	2.61	203	123	163	14.00	0.07	41.7	1.0	40.8	1.0	19.5	0.0	60	2	500	1	Sandstone.						
187	Schist.....	3.20	2.50	2.89	200	156	183	1.87	0.09	22.8	1.3	21.7	1.7	19.0	0.9	44	3	232	5	Schist.						
15	Shale.....	2.75	2.50	2.63	173	156	167	4.80	0.50	11.8	3.3	13.6	2.5	17.7	13.9	13	2	368	28	Shale.						
66	Slag.....	3.90	2.00	2.91	243	125	183	4.00	0.04	19.1	2.5	15.7	2.1	18.3	9.5	21	2	500	1	Slag.						
80	Slate.....	3.80	2.40	2.77	209	150	172	3.41	0.05	17.1	1.6	24.4	2.3	19.7	1.1	54	1	235	1	Slate.						
20	Syenite.....	3.05	2.15	2.74	190	134	171	3.06	0.09	14.4	1.6	26.6	2.8	19.3	17.3	23	3	257	2	Syenite.						
1	Travertine.....	2.70	2.70	2.70	166	166	166	0.005	0.005	5.9	5.9	6.8	6.8	13.0	13.0	4	4	24	24	Travertine.						

EXPLANATION OF RESULTS GIVEN IN TABLE

RESISTANCE TO WEAR

Resistance to wear is a special property in a rock, and although it depends to a large extent upon both the hardness and the toughness of the rock it is not an absolute function of these qualities.

The per cent of wear in the table refers to the dust and detritus below one-sixteenth of an inch in size worn off in the abrasion test. The test is made in the following manner: Eleven pounds (5 kg.) of broken rock between 1½ and 2½ inches in size, 50 pieces if possible, are placed in a cast iron cylinder mounted diagonally on a shaft and slowly revolved 10,000 times.

The French coefficient of wear is obtained by dividing 40 by the per cent of wear. Thus a rock showing 4 per cent of wear has a French coefficient of wear of 10. The French engineers, who were the first to undertake road-material tests, adopted this method of recording results. They found that their best-wearing rocks gave a coefficient equal to about 20. The number 20 was therefore adopted as a standard of excellence. In interpreting the results of this test a coefficient of wear below 8 is called low; from 8 to 13, medium; from 14 to 20, high; and above 20, very high. Rocks of very high resistance to wear are suited only for heavy traffic.

HARDNESS

By hardness is meant the resistance of a rock to the grinding action of an abrasive agent like sand, and it is tested as follows:

A core 1 inch in diameter, cut from the solid rock, is faced off and subjected to the grinding action of sand fed upon a revolving steel disk against which the test piece is held with a standard pressure. When the disk has made 1,000 revolutions the loss in weight of the sample is determined. In order to report these results on a definite scale which will be convenient the method has been adopted of subtracting one-third of the resulting loss in weight in grams from 20. Thus a rock losing 6 grams has a hardness of $20 - 6/3$, or 18. Experience has shown this to be the most convenient scale for reporting results. The results of this test are interpreted as follows: Below 14, rocks are called soft; from 14 to 17, medium; above 17, hard.

TOUGHNESS

By toughness is meant the resistance a rock offers to fracture under impact; such, for instance, as the striking blow given by a shod horse. This property is tested in a specially designed machine built on the pile-driver principle, by which a standard weight is dropped upon a specially prepared test piece until it breaks. The height in centimeters of the blow which causes the rupture of the test piece is used to represent the toughness of the specimen. Results of this test are interpreted so that those rocks which run below 13 are called low; from 13 to 19, medium; and above 19, high.

CEMENTING VALUE

By cementing value is meant the binding power of the road material. Some rock dusts possess the quality of packing to a smooth, impervious mass of considerable tenacity, while others entirely lack this quality. Cementing value should not be confused with the property possessed by Portland cement, which causes it to set into a hard, stone-like mass when mixed with water. The cementation test is made as follows:

The rock sample is ground in an iron ball mill with sufficient water to form a stiff, fine-grained paste. From the paste small briquettes 1 inch (25 mm.) in diameter and 1 inch high are molded under pressure. After thorough drying the briquettes are tested under the impact of a small hammer which strikes a series of standard blows. The number of blows required to destroy the briquette is taken as a measure of the cementing value of the dust. Some rock dusts, when thoroughly dried into compact masses, immediately slake or disintegrate when immersed in water. It is considered that the tendency to act in this way is not a desirable characteristic of a road material, as it would lead to muddy conditions on the road surface after rains. The test is interpreted so that cementing values below 10 are called low; from 10 to 25, fair; from 26 to 75, good; from 76 to 100, very good; and above 100, excellent.

WEIGHT PER CUBIC FOOT

The weight per cubic foot refers to the weight of the material in the form of a solid and not as broken stone.

has not yet been reached. In round figures, the cost of bituminous macadam runs about 25 to 40 cents per square yard in excess of ordinary "waterbound" macadam.

Some engineers contend that an ordinary plain macadam construction, followed by a thorough paint coat, is the most desirable form, but this is essentially surface treatment.

A system introduced in England by Arthur Gladwell, now known as the Gladwell system of bituminous road construction, requires the spreading of a mixture of sand and bituminous material or fines and bituminous material over the top of the No. 1 or first course of macadam followed by a No. 2 course of clean, dry stone and a second layer of mixed fines and bituminous material. The three layers are then rolled with a steam roller. The object of this form of construction is to secure a thorough filling of the second course of stone by the mixture of fines and bituminous material from both above and below.

Throughout this description the term "bituminous material" has been used as a generic term and should be read to include all forms of artificial binders which are in common use.

The details of the management of bituminous material are extremely important. It is known that a proper selection of the bituminous binder is vital to the success of construction. Standard specifications for bituminous material are not yet in complete agreement. There are certain chemical tests which it is known that good bituminous material should satisfy. It is quite possible that these chemical tests have not yet developed final form and that additional physical tests should be introduced to enable proper selection of material. For further details as to matter of pressure, temperature, viscosity, etc., the reader is referred to articles upon bituminous road materials.

**UNITED STATES DEPARTMENT OF AGRICULTURE
OFFICE OF PUBLIC ROADS AND RURAL ENGINEERING**

*Specification for the Construction of Bituminous Macadam by the
Penetration Method*

SEPTEMBER, 1914

SUBGRADE

The subgrade shall be considered as that portion of the road upon which the first course of broken stone is to be laid. The subgrade shall consist of good, sound earth brought to the proper elevation, alignment, and cross-section, and shall be rolled until firm and hard. The rolling shall be done with a roller of the macadam type weighing not less than ten (10) tons or more than fifteen (15) tons. Should earth be encountered which will not

compact by rolling, so as to be firm and hard, it shall be removed and suitable material put in its place and that portion of the subgrade again rolled. When the rolling is completed, the surface of the subgrade shall conform to the cross-section shown on the plans and shall have the proper elevation and alignment and shall be so maintained until the first course of stone is in place. If tracks or ruts are formed in the subgrade, the contractor shall scarify, reshape and reroll it.

Preparation of subgrade shall be paid for at the price bid per square yard.

CRUSHED STONE

The crushed stone used in this work shall be newly broken, of uniform quality throughout and free from tailings, slaty and flat fragments, soft or disintegrated stone, dirt or other objectionable matter.

The following designations and sizes shall obtain:

Dust. That portion of the product of the crusher which will pass through a screen having one-quarter ($\frac{1}{4}$) inch circular openings.

Chips. That portion of the product of the crusher which will be retained on a screen having one-quarter ($\frac{1}{4}$) inch circular openings and will pass through a screen having one (1) inch circular openings.

Screenings. That portion of the product of the crusher which will pass through a screen having one (1) inch circular openings, including the dust of fracture.

No. 2 Stone. That portion of the product of the crusher which will be retained on a screen having one (1) inch circular openings and will pass through a screen having circular openings not less than two (2) inches nor greater than two and one-quarter ($2\frac{1}{4}$) inches in diameter.

No. 1 Stone. That portion of the product of the crusher which will be retained on a screen having circular openings not less than two (2) inches nor greater than two and one-quarter ($2\frac{1}{4}$) inches in diameter, and will pass through a screen having circular openings not less than three (3) inches nor greater than three and one-half ($3\frac{1}{2}$) inches in diameter.

A sample of the stone when subjected to the hardness, toughness and abrasion tests as described in U. S. Office of Public Roads Bulletin No. 44, shall satisfactorily meet the following limiting values:

Hardness, not less than _____; toughness, not less than _____; and per cent of wear, not more than _____.

Bottom course. The bottom course shall consist of a single layer of No. 1 stone, of the thickness, when compacted, as shown on the plans, and shall be spread so that after being thoroughly

compacted with a road roller, of the macadam type, its surface will be paralled to and uniformly below the finished road surface by an amount equal to the thickness of the wearing course. When the bottom course has been thoroughly rolled, the voids between the stone shall be filled with stone screenings or coarse sand. In no case, however, shall such an amount of screenings or sand be used as to fill the bottom course to within less than one-half inch of its surface.¹

Second course. The second course shall consist of a layer of No. 2 stone evenly spread over the bottom course to a depth of three inches, loose measurement. This course shall be dry rolled until the fragments of stone are well keyed together and the surface conforms to the cross-section shown in the plans. In order to allow penetration of the hot bituminous binder applied in the manner hereinafter specified, the surface of this course shall be open and porous.

In the event that any course of stone shall have become rutted or loosened by travel before the application of the next succeeding course, the contractor shall restore said course of stone to its proper cross-section with such materials and in such manner as the engineer shall direct.

Bituminous binder. The bituminous binder shall conform to the specification for such material.² Sufficient and approved facilities for delivering and heating the binder shall be provided. It shall be maintained within a temperature range of 250° F. to 300° F. for tar products, and 300° F. to 350° F. for fluxed native and oil-asphalt products.

First application of bituminous binder. The hot bituminous binder shall be uniformly distributed over the second course at the rate of 1½ gallons to the square yard, by either pouring from approved pouring pots or applied under pressure from a tank wagon equipped with hose and nozzle of a type approved by the engineer. Immediately after this application, clean stone chips shall be spread over the surface in sufficient quantities to just

¹ Worn macadam which is to be resurfaced with bituminous macadam shall first be cleaned of all loose dirt and foreign matter, and then scarified to a depth of three (3) inches. The loosened material shall be harrowed and reshaped to the proper crown by the use of a road machine or rakes, and sufficient new No. 1 stone shall be added to yield, when compacted, a bottom course of the required thickness. At the sides shall be formed shoulders of well rolled macadam, gravel, or earth, not less than three (3) feet in width.

² Climatic conditions, volume and character of traffic, kind of stone used and availability, are important factors to be considered in the proper selection of bituminous materials. Since any of these factors may vary greatly in different sections of the country, it is inadvisable to include a general specification for the bituminous material. Proper specifications will be furnished upon request if information relative to the above mentioned factors is given.

completely fill the surface voids, after which the course shall be thoroughly rolled. When the rolling is completed, any surplus chips shall be swept from the surface. The bituminous binder shall be applied only during dry weather, and the stone of the second course must be dry and clean at the time of application.

Seal coat. A seal coat of hot bituminous material shall be uniformly distributed as above described, at the rate of one-half ($\frac{1}{2}$) to three-quarters ($\frac{3}{4}$) of a gallon to the square yard. It shall be immediately covered with a layer of clean stone chips, in an amount sufficient to take up all excess bituminous material, and shall then be thoroughly rolled.

Weather. No bituminous material shall be applied at any time when the air temperature is below 60° F., or when the air temperature within the preceding twenty-four hours has been 35° F. or lower.

Specifications for Bituminous Macadam—Mixing Method

U. S. Office of Public Roads and Rural Engineering

SUBGRADE SAME AS FOR PENETRATION METHOD

Upon the concrete or macadam base constructed as hereinbefore specified shall be laid a wearing surface of bituminous macadam, as follows:

MATERIALS

Crushed stone. The crushed stone used in this work shall be newly broken, of uniform quality throughout and free from tailings, slaty and flat fragments, soft or disintegrated stone, dirt, or other objectionable matter.

The following designations and sizes shall obtain:

Three-quarter ($\frac{3}{4}$) inch stone. That portion of the product of the crusher which will be retained on a screen having one-half ($\frac{1}{2}$) or five-eighths ($\frac{5}{8}$) inch circular openings, and will pass through a screen having one and one-eighth ($1\frac{1}{8}$) or one and one-quarter ($1\frac{1}{4}$) inch circular openings.

Chips. That portion of the product of the crusher which will pass through a screen having one-half ($\frac{1}{2}$) or five-eighths ($\frac{5}{8}$) inch circular openings, and be free from any material which will pass through a one-eighth ($\frac{1}{8}$) inch screen.)

Bituminous binder. The bituminous binder shall conform to the specification for such material.¹ Sufficient and approved facilities for delivering and heating the binder shall be provided. It shall be maintained within a temperature range of 250° F. to

¹ Climatic conditions, volume and character of traffic, kind of stone used and availability, are important factors to be considered in the proper selection of bituminous materials. Since any of these factors may vary greatly in different sections of the country, it is inadvisable to include a general specification for the bituminous material. Proper specifications will be furnished upon request if information relative to the above mentioned factors is given.

300° F. for tar products, and 300° F. to 350° F. for fluxed native and oil-asphalt products.

CONSTRUCTION

Wearing surface. The wearing surface shall consist of a single layer of a mixture of the three-quarter ($\frac{3}{4}$) inch stone and bituminous material, above described, uniformly spread over the base to a thickness of not less than three and one-half ($3\frac{1}{2}$) inches before rolling.

The mixture shall be in the proportions of one (1) cubic yard of stone and eighteen (18) to twenty-one (21) gallons of the bituminous material. The exact amount of the latter will be determined by the engineer within the above limits and the amount so determined shall be used by the contractor.

The stone shall be heated in such a manner that no part of it shall have a temperature higher than 250° F. or lower than 200° F. To the heated stone shall be added the hot bituminous material and the whole thoroughly mixed until the entire surface of each particle of stone is covered with the bituminous material.

The mixing shall be done in a mechanical mixer so designed, constructed and operated that it will dry and heat the stone to a temperature of 250° F., and will thoroughly mix this heated stone and the bituminous material without in any manner damaging the latter by overheating.

The mixture shall be transported from the mixer to its place on the road in wheelbarrows, carts or wagons and dumped upon dumping boards, from which it shall be shoveled into place. The temperature of the mixture at the time of spreading shall be such that it may be readily spread in a layer of uniform density and thickness. Lumps that can not be readily broken up by the spreader shall be rejected. The operation of transporting, shoveling and spreading shall be so conducted that it shall not cause any segregation of any part of the mixture. When the mixture has been properly spread, it shall be thoroughly compacted by rolling with a roller weighing not less than ten (10) tons or more than fifteen (15) tons and heavy ramming at places inaccessible to the roller. All of the mixture shall be rolled or tamped during the same day that it is laid.

Seal coat. To the well-rolled surface shall be applied a seal coat of bituminous material at the rate of from one-half ($\frac{1}{2}$) to three-quarters ($\frac{3}{4}$) of a gallon to the square yard. The application may be made from a hose connected to the supply tank or by approved pouring pots, and shall be evenly broomed over the surface if necessary to obtain a uniform distribution. The coated surface shall be immediately covered with a layer of chips of sufficient thickness to take up all excess of bitumen. The surface shall then be finished by thorough rolling.

Specifications for Asphaltic Materials

Specifications for asphaltic materials for highway building may be drawn in one of three ways. There may be (1) a so-called "wide-open" or blanket specification, the limits of which are so broad as to include practically all available products; (2) a "closed" specification, describing a particular product which it is desired to use; or (3) an alternate specification, which describes separately the main types or kinds of asphalt, and calls for separate bids on each.

In favor of the wide-open specification it is contended that it does not discriminate against any product and tends to secure the broadest competition. When accompanied by the provision that the low bid must be accepted such a specification results, its critics assert, in eliminating considerations of relative quality and desirability. There is a further objection raised, that in order to admit a wide range of products the limits of the specification must be so broad as to include the least desirable and cheapest products as well as those of higher price and, presumably, of greater desirability.

An advantage claimed for the closed specification is that it enables the purchaser to obtain precisely that material which it has been determined shall be used. This form is objected to on the ground that it limits competition and may result in the purchaser being mulcted for a higher price than would otherwise be paid. The latter objection does not apply to products which are sold at a fixed price to all purchasers, whatever specifications may be in force, but the objection remains as to a policy which may be considered one that confers a monopoly.

The alternate specification, by classifying or separately describing types of asphalt and calling for separate bids on each, permits the choice of materials on the basis of relative cost and quality, it being possible under such a specification to accept the lowest bid contemplating the use of any class of asphalt. Under an open specification the buyer usually is limited to that which may be the cheapest. Against the alternate specification it is contended that the classification of asphalts is unnecessary, and that one description can and should be drawn so as to include all available materials, however great may be their variation in origin, quality and price.

The Office of Public Roads and Rural Engineering employs the alternate form of asphalt specification and calls for separate bids on "oil asphalt" and "fluxed native asphalt" for road building purposes. The Committee on Road Materials of the American Society of Civil Engineers has reported that: "For the present, at least, whenever comprehensive specifications are to

be prepared so as to admit a variety of types of bituminous materials, separate specifications as may be necessary should be prepared for each type."

Brick Roads

Vitrified paving brick have been in use in this country a little more than thirty-five years as a wearing surface for streets and highways. In their early history little attention was given to using them in the most advantageous way, either as to durability or as to the possible satisfaction in their use. It was rather a commingling of varied ideas with a good material, with no definite realization of what is really possible in a brick street constructed under the most approved methods of today.

Vitrified paving brick are manufactured from fire clays and shales which are found in various regions throughout the United States. No two deposits of these shales or clays are exactly alike; they do not burn alike either in color or in the amount of heat required to bring them into the best condition adaptable for their use, so that the raw material must receive slightly different treatment at each of the factories. On this account brick of different manufacture differ in appearance.

A brick burned sufficiently to develop the best quality from any one of the clays and shales used is almost impervious; at least sufficiently so that the amount of moisture absorbed, regardless of temperature, does not affect the brick in any way.

In the use of vitrified brick for a wearing surface, due consideration must be given to the amount and character of the traffic in determining the width of the road and the character of construction. The amount of money possible to expend must also have due weight. The available local materials which may be used in the construction of the road in addition to the brick, must also be taken carefully into consideration. For example, it is necessary to determine whether concrete shall be used as foundation, and, if so, of what the concrete shall consist, or whether there shall be any artificial foundation at all. The question of whether the road is to be located in the northern portion of the country subject to extreme climatic conditions or in the extreme south where low temperature need not be guarded against is of great importance. The question of drainage also enters materially into the problem.

The type of the road therefore must be influenced by some one or more or even all of the foregoing, as every feature to a greater or less extent bears a particular relation to the economy of the road itself. To illustrate: the black mucky soil of somewhat difficult drainage of northern Illinois where practically all of the thorough-

fares are subject to a traffic of numerous and heavily loaded vehicles, and subject also to extremes of low temperature and liable to consequent damage from frost, require the best and more expensive type of roads. In and about the Gulf Coast where the soil for the most part carries a large proportion of sand and is not subject to frost action economical roads can be built without any artificial foundation at all by merely preparing the grade to correspond with that of the finished highway. The requirements for these two types of roads as to local conditions to a very large degree equalizes the cost in respective localities. For instance, in northern Illinois the brick on account of freight rates are slightly less in cost and the material, such as gravel and broken stone, which enter into the foundation are of low cost so that a road built in northern Illinois corresponds in price to the road equally adapted to conditions found in the South and this state of affairs very largely obtains throughout the country.

As to the different types and kinds they may be approximated as follows: the best and most expensive type that shall meet severest conditions as well as severest traffic must be made with a carefully drained and thoroughly compacted subgrade, the surface of which shall be made to exactly conform with that of the finished highway. Upon this subgrade must be placed a concrete base finished with a smooth surface and from 4 to 6 inches in depth. On this base a compressed sand cushion to a uniform depth of two inches is placed. Upon this 2-inch sand cushion must be placed the brick with the best edge up. These bricks after being so placed must be rolled and ironed out so that the plane presented by the surface shall be entirely free from any depressions. Following this condition the interstices shall be completely filled with a mixture in uniform preparation of 1 to 1 of sand and portland cement. Provisions shall also be made along either curb for contraction and expansion. Standard specifications for various types of brick pavements may be obtained from the National Paving Brick Manufacturers Association, Engineers' Building, Cleveland, Ohio. The cheapest and least expensive type eliminates from the foregoing the foundation of concrete and even cement filler so that a road in the sandy districts can be made based upon the expenses of the brick, the curb and the preparation of the grade. Intermediate conditions necessarily obtain here and there throughout the country where with good judgment economy may be greatly subserved in the manner and method of building with due consideration of the traffic to which the roads respectively are to be subjected. Let it be thoroughly understood that the highest and best type is not only satisfactory and sanitary but of the greatest durability. However, the cheaper type is oftentimes advisable because of lower first cost and traffic requirements.

Asphalt Impregnated Brick

During 1915 attention has been directed to the possibilities of asphalt impregnated brick. The idea of impregnating brick with bituminous material is not new. In 1893 brick boiled in coal tar were laid in Portland, Ore., and remained in service 17 years. About 1907 nose brick boiled in asphalt were laid along the tracks of the Los Angeles Electric Railway Corporation and 2500 similar brick were laid along tracks in San Francisco about 1912. Brick boiled in bituminous material have also been laid in Nashville and Chattanooga.

The method of treating brick which came into prominence in 1915 is designed to fill completely the pores in the brick. As the porosity of different grades and makes varies considerably, the quantity of impregnating material required will range from about 6 to 15 per cent of the volume of the brick. As a result of the treatment it is claimed that the brick become impervious to moisture, the bituminous jointing material adheres more firmly to the treated than to the untreated brick, and the wearing properties, as indicated by the standard rattler test, are greatly improved.

Results of tests of untreated and asphalt impregnated brick. Each sample consisted of five untreated and five treated brick

SAMPLE	1	2	3	4	5	6	7	8	9
Weight in pounds:									
Before treatment....	50.66	48.81	46.50	53.35	45.25	48.65	49.75	47.95	50.03
After treatment....	56.75	54.01	48.97	55.77	47.49	51.33	54.60	49.94	54.53
Asphalt used.....	6.09	5.20	2.47	2.42	2.24	2.68	4.85	1.99	4.50
Loss in weight, pounds:									
Untreated.....	27.02	17.39	28.81	17.19	13.93	11.88	19.57	13.63	11.78
Treated.....	8.38	8.96	6.22	10.07	6.51	6.83	7.36	6.46	6.25
Loss in weight, per cent:									
Untreated.....	53.34	35.63	61.96	32.22	30.79	24.42	39.34	28.43	23.55
Treated.....	14.77	16.59	12.70	18.06	13.71	13.31	13.48	12.94	11.46
Broken brick:									
Untreated.....	1	0	3	0	0	0	0	0	0
Treated.....	0	0	3	1	0	0	0	0	0

This last advantage is indicated in the accompanying tabulation of tests of untreated and treated "second" brick conducted by Robert W. Hunt & Company. Each test was made with five untreated and five treated brick, 225 pounds of small shot and 75 pounds of large shot, the rattler making 1800 revolutions at the rate of 30 revolutions per minute. The increase in wear due to impregnation will, it is stated, enable manufacturers to stop their burning at a lower temperature than is now customary, thus

materially reducing the number of poor brick in a kiln, and to obtain the necessary strength by impregnating the brick. It is also claimed that grades of brick unsuitable for pavements may be made into satisfactory pavers by impregnation.

The manufacture of asphalt impregnated brick is described as follows: The burning is stopped two or three days earlier than for vitrified pavers, and as soon as the brick have been cooled to a handling temperature they are run on trucks into a tight cylinder. The cylinder is subject to a vacuum of 25 inches to remove air from the pores of the brick, and is then filled with hot asphalt under a pressure of about 160 pounds per square inch. This pressure is maintained for two or three hours. The asphalt is then drained away and the brick removed to an annealing chamber to cool.

Concrete Roads

Types.—The methods of construction of concrete roads divide them into one course, two course and one and two course reinforced.

Materials.—1. Portland Cement. The cement shall meet the requirements of the United States government for Portland cement or of the standard specifications for Portland cement of the American Society for Testing Materials.

2. Fine Aggregate. Fine aggregate shall consist of sand, crushed stone or gravel screenings, graded from fine to coarse, and passing when dry a screen of $\frac{1}{4}$ -inch mesh. It shall be preferably of silicious material, clean, free from soft particles and dust (both loose and occurring as a coating on the grains), loam, vegetable or other deleterious material; and not more than 20 per cent shall pass a sieve having 50 meshes per lineal inch, and not more than 5 per cent shall pass a sieve having 100 meshes per lineal inch. Fine aggregate shall be of such quality that mortar composed of one part Portland cement and three parts fine aggregate, by weight, when made into briquettes, will show a tensile strength at least equal to the strength of 1:3 mortar of the same consistency, made with the same cement and Standard Ottawa Sand. In no case shall fine aggregate containing frost or lumps of frozen material be used.

3. Coarse Aggregate. Coarse aggregate shall consist of stone or gravel, graded in size, retained on a screen of $\frac{1}{4}$ -inch mesh, and passing a screen of $1\frac{1}{2}$ inches mesh. It shall be clean, hard, durable and free from all deleterious matter and shall contain no soft, flat, or elongated particles. In no case shall coarse aggregate containing frost or lumps of frozen material be used.

4. Natural Mixed Aggregates. Natural mixed aggregates shall not be used as they come from deposits, but shall be screened and remixed to agree with the proportions specified.

5. Water. Water shall be clean, free from oil, acid, alkali, or vegetable matter.

Equipment.—In addition to the usual equipment needed in the preparation of the subgrade or foundation for all types of roadways, there will be required for the construction of a concrete roadway a good concrete mixer of the batch type provided with traction power, a sufficient amount of 2-inch lumber capped with angle irons or steel side arms for side forms, wheel-barrows, shovels, the finishing and other small tools owned by every contractor doing concrete work and some means for hauling materials.

On large work or long hauls or in districts where men and teams are scarce, hauling on industrial railways and with traction engines and motor trucks has been found to be economical, and the comparatively large amount of water required can probably be best obtained from the nearest source of supply by pumping through small metal pipe lines with small gasoline engines, rather than by hauling in tank wagons with teams.

Foundation.—The subgrade or foundation upon which concrete is to be laid should be made flat and brought to a firm unyielding surface by rolling, and all soft, spongy or yielding spots and all vegetable or perishable matter should be entirely removed from the subgrade and the space refilled with gravel, broken stone or other suitable material. Special attention should be paid to drainage and water must be kept from reaching the foundation by means of open ditches or tile or French drains, provided with suitable outlets. Old macadam or gravel roadways make ideal foundation upon which to lay concrete, provided the same are scarified and made flat and the surface sealed with clay or loam or other material thoroughly wet and rolled, which will prevent the grout from the concrete running into the sub-base and will prevent any bond between the sub-base and the pavement. The surface of the sub-base must be smooth and free from all irregularities.

One-Course Roadway.—Upon the properly prepared subgrade concrete should be deposited having a thickness of at least 5 inches at the sides and 7 inches at the crown. It should be made in the proportion of at least one bag of Portland cement, $1\frac{1}{2}$ cubic feet of fine aggregate and 3 cubic feet of coarse aggregate. The mixture should be of such consistency as to settle to a flattened mass and yet cause no segregation of the aggregate and the surface struck off with a template cut to the proper shape of the road and running on the side forms. The rough places left after the use of the template, should be smoothed with a wooden float.

Two-Course Roadway.—Upon a properly prepared subgrade should be laid concrete mixed in the proportion of at least 1 sack of cement to not more than $2\frac{1}{2}$ cubic feet of fine aggregate and not more than 4 cubic feet of coarse aggregate, having a thickness of at

least 4 inches at the sides of the road and 6 inches at the crown. The concrete should be mixed as wet as is practicable, and should be placed as soon after mixing as possible but in no case should more than thirty minutes elapse between the mixing and the placing of the concrete base. The concrete base should be deposited in strips extending across the full width of the area paved and should be brought to a surface the thickness of the wearing surface below the finished surface of the roadway.

The concrete base before it begins to harden should be covered with a wearing course at least 2 inches thick composed of one sack of cement, and 1 cubic foot of suitable fine aggregate to $1\frac{1}{2}$ feet of coarse aggregate, ranging in size from $\frac{1}{4}$ inch to $\frac{3}{4}$ inch.

The wearing course should be placed as soon as it is mixed and in no case should more than forty-five minutes elapse between the mixing of the concrete base and the finishing of the wearing course.

Protection.—The concrete shall be sprinkled with water as soon after finished as may be possible without pitting the surface. It shall be kept moist in this manner for at least 10 days during which time it shall be protected from the elements by covering with canvas, sand or earth. No travel shall be allowed upon it until the concrete is 14 days old.

Joints.—To provide for free movement of the concrete, the road should be laid with joints of $\frac{1}{4}$ -inch width not more than 30 feet apart. Such joints should be vertical and extend entirely through the concrete. They should be filled with tar paper or tar felt, or a waterproof filler.

Crown.—The road should be given a crown at the center of one-hundredth to one-seventy-fifth the width of the road.

Reinforced Concrete Pavement.—When the road is 20 or more feet wide, reinforcing shall be used; the same shall consist of wire fabric or of plain or deformed steel bars. The cross-sectional area of the transverse reinforcing shall amount to at least 0.041 square inch per lineal foot of length of roadway measured parallel to the axis of the street. The cross-sectional area of the reinforcing metal running parallel to the center line of the pavement shall amount to at least 0.04 square inch per foot of pavement width and the cross sectional area of the reinforcing metal which is perpendicular to the center line of the pavement shall amount to at least 0.05 square inch per foot of pavement length. The reinforcing shall be placed 2 inches from the upper surface of the pavement, and shall be lapped, where necessary, sufficiently to develop the full strength of the metal. The reinforcement shall extend to within 2 inches of, but not across, all joints.

Asphalt Blocks on Country Roads

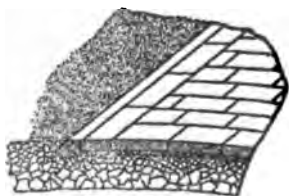
As designed and manufactured for use on country roads, the asphalt blocks are 5 inches wide, 12 inches long, and 2 inches deep,

weigh about eleven pounds each, and have a specific gravity of about 2.40.

The asphalt block was developed and perfected on the theory that crushed trap rock, on account of its preëminent hardness and inherent grittiness, made the best known material for a roadway surface, the one thing needed being a cement, or binding material, to keep all of the particles permanently in place. This was accomplished by the use of an asphaltic cement to bind together the properly graded particles of crushed trap, the hot mixture being consolidated by tremendous pressure into blocks so dense and free from voids as to be practically non-absorbent. In the asphalt block, therefore, we have an asphaltic concrete, or macadam, mixed, in exact proportions, at a central plant, under conditions insuring absolute uniformity, and receiving the compression necessary to produce a dense and non-absorbent material.

Not only has a special block been produced, but a special method of construction has been worked out, designed to utilize what is left of the worn and rutted macadam road as a foundation for the blocks. This is accomplished by scarifying the surface, if necessary, filling up the deep ruts, rolling with a heavy steam roller, and laying upon the surface of the old macadam, a bed of cement mortar about 1 inch in thickness, to serve the double purpose of forming a firm unyielding bed for the blocks, and binding them securely to the macadam foundation underneath. By this method the material used in the original construction of the road is not thrown away, but used as foundation for a permanent wearing surface. Where the old macadam is too thin, or too badly worn to be safely used as a foundation, it will be necessary to lay a concrete base, but usually there is broken stone enough in the old macadam to supply what is needed for laying concrete.

A pavement may be laid of any desired width, contour, grade, or crown. It is perfectly feasible to pave one-half of the roadway, or only a narrow strip in the center, and extend the paved area at a later date as traffic necessities require, or as appropriations become available. It is not necessary to set curbstones or head-



ing stones to border or define the paved area, since a row of stretcher blocks held firmly in place by a shoulder of mortar, as shown in the sketch, answers the purpose perfectly and leaves the entire roadway surface smooth and uniform.

A good example of this construction is on the Albany Post Road, through the villages of Hastings-on-Hudson, North Tarrytown and the Town of Mount Pleasant, N. Y., and on the Boston Post Road in Pelham Manor and Rye, N. Y.

ROAD MAINTENANCE AND REPAIR

These terms are quite generally confused and are often used without distinction. The essential difference in practical road work is one of size or quantity. Large repairs may be reduced by more frequent attention to small repairs; these in turn by still closer attention become very small repairs and finally by a system of practically constant attention develop into maintenance. A well maintained road surface, therefore, will generally require no repairs until reconstruction or replacement is necessary. Sometimes work on culverts, bridges and the renewal of shoulders after heavy rains are considered repair.

The repair of gravel and earth roads is well explained in the article on the construction of the same.

To distinguish the repair of macadam roads from their maintenance, the word repair may be restricted to those operations commonly called resurfacing. When an old macadam is worn so thin or becomes so full of chuck holes that small scattered repairs are insufficient to maintain it, it is usually resurfaced; the period between resurfacing operations on a large number of roads as reported by the United States Office of Public Roads is about 6.5 years. It is becoming increasingly common to resurface macadam roads with some form of bituminous construction. If the old macadam surface is first scarified or picked up with the roller or by hand labor, and considerable new stone added, the repair operations go forward from this point as in bituminous macadam construction. When no bituminous material is used in macadam road repairs, the scarified surface is brought to true crown and graded by the addition of new stone and thoroughly rolled and bonded as in ordinary macadam road construction. There is considerable variation in the method and amount of scarifying or loosening of the old macadam surface; e.g., if a macadam road has simply developed a horse track or worn traveled way for a width of 6 to 8 feet in the center, the road is sometimes repaired by thoroughly sweeping and adding sufficient new stone to restore the crown without scarifying. Sometimes the edges only of a macadam roadway are scarified or picked to insure a bond of new stone with the old road course. Scarifying or picking up of the old road surface may be entirely omitted and new stone put in place without disturbing the road crust. This should never be done without first thoroughly scouring the old surface

with stiff brooms and flushing with hose, if possible, otherwise a dust layer will be present and no bond develops between the new and old material. Of course, if a hose cannot be had, thorough dousing with a sprinkling cart will suffice.

Many macadam roads are now repaired by what is known as surface treatment. A typical example of this process is as follows: The old road is thoroughly cleaned of all dust and refuse; and an application of bituminous material is made on the road of from 0.15 to 0.5 gallon to the square yard followed by a uniform coating of screened trap rock, gravel or coarse sand. The material should not exceed $\frac{1}{4}$ inch in greatest diameter. If ruts or holes are present, they should be brought up to a true surface with additional bitumen and coarse screenings. The road is now rolled; another application of 0.25 gallon to the square yard of bituminous material is made and the second course of screenings applied. Such depressions as developed are of course filled with screenings as the work proceeds and a sufficient excess of bituminous material should be given to such spots. A supply of surface screenings should be left along the road when such repair methods are used so that they may be spread subsequently to take up any excess of bituminous material that develops on the surface.

Maintenance

Undoubtedly the best system of maintenance for all roads is that which provides for the permanent and sometimes continuous employment of skilled laborers who have charge of particular sections of road, or who may be assigned to any part of the county or other road unit where there is work most needed. Men employed in this way become experts in their particular line and if they make mistakes one year or in one place, they are apt to correct them, whereas under the labor tax system, mistakes are often repeated. If one man is employed to look after a particular stretch of road, he will learn to take pride and interest in his work.

The continuous maintenance system has been adopted in this country only to a limited extent. It has been used by the Massachusetts highway commission for several years. The New York State highway commission introduced it in the year 1910 for the maintenance of State roads, and Allegheny County, Pennsylvania, employs it for the maintenance of about 100 miles of county roads. The Office of Public Roads and Rural Engineering has also determined its effectiveness on experimental stretches.

While it would be manifestly impossible to adopt the continuous maintenance system throughout the country on account of limited resources, and sparse population, still there are many places where it might be used with success. It would be difficult to find a county which is so poor that it could not afford to employ continuously

eight or ten laborers and three or four teams to maintain and repair its principal roads. That such a plan would be more effective than the labor tax system has been often proved.

Of all our roads, the earth roads are probably the most neglected. The first and last principle in the maintenance of earth roads is to keep the road well drained. Water is the great enemy to our clay or soil roads, and must be removed immediately, or mud results. To insure good drainage, the ditches must be free and the smooth crown of the road maintained. For this purpose the split-log drag or an equivalent drag is very useful and, at the same time, inexpensive. The drag can be used on a sand-clay road or gravel road with good effect.

The following points govern dragging on earth, gravel or sand-clay roads: The drag should be light, and should be hauled over the road at an angle of about 45 degrees so that only a small amount of earth is pushed to the center of the road. The driver may ride on the drag and should not drive faster than a walk. Some men like to weight the drag and direct it by handles arranged like plow handles. Dragging should begin on the side of the road, and the return made on the opposite side. Unless a road is already in good condition, it should be dragged after every heavy rain, when the mud will puddle well, and still not adhere to the drag. A few trips over the road will give the operator a clue as to the proper and best time to drag. If a road is dragged immediately before a cold spell, it will freeze smooth.

Always drag a little earth toward the center to keep the slope of the crown about an inch to the foot. If the drag cuts too much, shorten the hitch or change the weight on the drag. The results from dragging are obtained only by repeated operations. A good system of dragging is that which is practiced in Kansas and Iowa, where road authorities are authorized to let contracts to farmers for dragging the roads abutting their lands. The cost of dragging will be for from \$0.75 to \$1.25 per mile per complete dragging of several trips. The cost will depend on the width and price of teams. From 15 to 30 draggings should be given a road the first year.

It is impossible sometimes to hold a road of soft material together during protracted rains and especially in winter when freezing occurs at intervals; but conditions will be greatly improved by the construction of underdrains in cuts along side hill sections or where groundwater shows a tendency to appear on the surface. The expense of subdrainage, if properly installed, will invariably find return in the improved state of the road during wet weather.

With reference to the maintenance of macadam roads, it is pertinent to state at the outset that it is doubtful practice now

to patch macadam roads without using some form of artificial binder. A few automobiles a day passing a well made patch will frequently destroy it. There are, however, roads where a strictly macadam surface must be maintained. In repairing such roads, the stones should be applied only after the depressions have been thoroughly cleaned with stiff brooms and it is desirable to pick the edges with hand picks. The stones should be thoroughly wet, rammed and bound with fines. An essential feature of all stone road repair is to have a supply of stone and binding material at frequent intervals, not less than 100 tons to the mile. Do not attempt to patch a road with stone greater than $1\frac{1}{4}$ inches in longest dimensions and use clean screenings. Road sweepings or organic matter and rubbish must never be used to bond stone patches. The maintenance of all kinds of macadam roads will be more effective if such roads are rolled in the spring with a steam roller when the frost has left the ground.

Where a patrolman has charge of waterbound macadam roads, he should take advantage of all wet weather to discover depressions in the road and to improve drainage. A patrolman should also remove all loose stones as they are particularly injurious to automobile tires and to the road used by automobiles. Such stones should be collected in piles of sufficient size so that no stone is wasted. An important item of maintenance of macadam roads is the paring of the shoulders and attention to weeds and sod which encroach on the roadway. If a road has been lined and graded it should be possible to cut weeds and grass on the shoulders with a mowing machine.

The importance of all forms of maintenance on roads is becoming more clearly recognised. It is an administrative problem. Where good business management is introduced, success follows. It is quite possible that extensive modern roads can be absolutely maintained for an indefinite period if they are given the proper surface treatment at necessary intervals. Frequently, however, even the best constructed road depreciates and ultimately requires rebuilding, because of the failure to properly systematize the maintenance.

DUST PREVENTIVES

Until comparatively recent years, the macadam road, if properly constructed of suitable material, was theoretically correct and practically sufficient to withstand the average traffic of our rural communities. It was dependent for its bond upon the dust produced by traffic, and so long as this dust remained upon the road surface to be washed into the interstices by occasional rains, a macadam road gave excellent and satisfactory service. With the advent of modern fast motor traffic, however, these roads began to deteriorate rapidly, since the rubber tire created practically no dust, but raised such as there was and allowed it to be carried away from the surface. This displacement not only robbed the road of valuable binding material, but created a menace to the health and comfort of the community. The need for a remedy soon became of paramount importance, and we have at present a great variety of materials for the purpose of laying the dust and thus tending to preserve the surface.

Water has been, of course, the best known and most generally employed dust preventive. It effects a mechanical bond between the particles of dust and rock, and with certain types of rock it has been shown to develop a chemical bond by hydrolyzing some of the rock components with the formation of colloidal cementing materials. The effect, however, is only temporary, and under heavy motor traffic, in dry weather, continual sprinkling is necessary which soon becomes an expensive item. Sea water has been tried with better success, owing to the fact that certain magnesium and calcium salts contained in it are capable of retaining moisture for a considerable length of time. The large amount of common salt also contained forms an objection to sea water, since in wet weather it leads to the formation of a salty mud which is injurious to the paint and iron work of vehicles. The good results of sea water without its disadvantages are obtained by the use of calcium chloride which is obtained as a comparatively cheap by-product in the manufacture of soda by the ammonia or Solvay process. This material was formerly applied in solution, but recently it has been prepared in a fine granular form to be spread over the road surface in a thin layer. It takes up water immediately, giving the surface a damp appearance, and proves quite efficient where the average moisture in the atmosphere is sufficient to feed the salt. Otherwise, an occasional light sprinkling with water is

necessary. The salt is, of course, washed away by repeated rains and must be replenished from time to time, so that the cost of the treatment is largely dependent upon local climatic conditions.

The purpose of the above-mentioned materials has been essentially to retain water as a binding agent in the road surface. Another material, which of itself contains some excellent binding qualities is commercially known as "Glutrin." It is a concentrated waste sulphite liquor obtained by the evaporation and treatment of liquors obtained in the manufacture of paper from wood pulp by the sulphite process. This material, diluted with water and used during the puddling of gravel and macadam roads, produces a hard surface, and also acts to reduce the formation of dust. For maintenance work, the material can be applied to the surface with a watering cart.

The waste molasses or "black strap" from sugar refineries in conjunction with milk of lime has also been used in surface treatment, and this gives some promise of becoming an economic and satisfactory material in localities where it can be obtained cheaply. It depends for its binding value upon the formation of calcium sucrares by the action of lime on the sugar contained in the molasses. These are tough, sticky substances, sparingly soluble in water and possessing considerable binding value. The use of this material is at present, however, an experimental proposition.

The greatest development in the preparation of dust preventives has been made in the utilization of bituminous products such as petroleum, coal tars and water-gas tars. These materials were first used in their crude state, but the results were only partially satisfactory, so that now we have to deal almost entirely with refined products. Practically the only exceptions to this statement are the recently exploited Trinidad oils, which consist naturally of a light volatile fluid carrying a large amount of true asphaltic base, and some of the more fluid crude California petroleum which are all of an asphaltic nature. Artificial products in some ways resembling the Trinidad oils have been produced by fluxing and cutting back some of the oil asphalts with volatile distillates. Some nonasphaltic petroleum preparations are used with satisfactory results as dust preventives and in proportion to their viscous or adhesive quality, make the fine particles of dust adhere to each other, thereby holding the powdered top dressing in a moist cushion in the center of the road, consequently helping to preserve macadam roadbeds against pitting or raveling.

In order to facilitate the application of petroleum products, more particularly to park roads and suburban streets, emulsions have been prepared with some cheap soap as the emulsifying agent. When such an emulsion is properly compounded, the oil becomes readily miscible with water and can be successfully applied from

an ordinary sprinkling cart. Many of the large producers now have on the market so-called emulsified oils which contain a proper amount of soap to permit of their being mixed with water quite readily.

Increasing quantities of tars which are obtained as by-products from our gas and coke industries, are being used for the manufacture of dust preventives and road binders. Low carbon coke oven tars and water-gas tars or mixtures of the two when properly refined are the most desirable of this type of product for cold surface applications; and a considerable amount of work is being done with light tars carrying a small percentage of an oil asphalt in solution.

The cold application of any of the types of petroleum or tar products may be made when the material is sufficiently fluid, but the more viscous products must be heated. In either case, best results are obtained by first cleaning and repairing the road surface, after which an application of sufficient material to uniformly cover the surface should be made. The quite common mistake of flooding the surface and permitting large quantities of material to go to waste in the ditches should be guarded against. When possible, traffic should be kept off the road for ten or twelve hours to allow the application to penetrate thoroughly, after which a light coat of sand or stone screenings may be spread over it. A treatment of this character not only keeps down the dust for some time but, when a proper grade of material is used, forms a protecting mat which prevents excessive wear on the road surface.

A clean, practically dustless surface is the prime requisite for any form of successful surface treatment, and neglect to have such a properly prepared surface is too frequently responsible for unsatisfactory results. The surface should be reasonably clean for the application of a dust preventive, since it is not the purpose of such an agent to lay any quantity of dust which may be present on the road, but rather to hold the products of wear for a period after the application has been made.

HIGHWAY BRIDGES AND CULVERTS

The proper material to be used in the construction of a bridge or culvert depends almost wholly on local conditions, such as area of waterway required, character and amount of traffic, available funds, etc. For bridges of considerable span, steel is commonly used, though long arches of concrete, stone or brick are not unusual. For the shorter spans up to 30 or 40 feet, reinforced concrete is well adapted. Culverts are built of various materials, such as stone, brick, concrete, and pipe of cement, vitrified clay, corrugated iron, or cast iron. Wood is also frequently used, but the high cost of maintenance, and the inconvenience and discomforts attending periodic repairs or renewals make it a very undesirable material of which to construct highway bridges or culverts, and its use should be avoided.

Steel Bridges

Because of its toughness and great unit strength, steel is peculiarly well adapted for use in bridge construction. Cast and wrought iron were formerly much used for this purpose, but in recent years have been generally supplanted by steel.

A complete discussion of the subject of steel bridges would occupy too much space to be undertaken here. There are a few essential details, however, which may be profitably pointed out.

Design

The design of steel bridges is now almost an exact science, and most of the bridge companies doing business in this country are amply equipped for executing designs under any reasonable set of conditions that may be imposed. It is obviously bad practice, however, to invite bids for furnishing and erecting a proposed bridge from these companies upon their own plans, without first having prescribed a complete and definite set of conditions to which the designs must conform. Otherwise, in the absence of a standard of excellence, no adequate comparison can be made of the bids received. Also, irresponsible parties are likely to secure the contract by submitting low bids with very light designs. Provision should always be made for having bridge designs checked by a competent, disinterested designer.

Loading

The loading which a highway bridge should be designed to sustain depends in general on the local traffic conditions. Due allowance, however, should always be made for reasonable increases both in the amount of traffic and in the weight of concentrated loads. For rural bridges it is usually sufficient, in designing the floor system, to provide for a uniform live load of 125 pounds per square foot, or for a load of 20 tons concentrated on two axles 10 feet apart, with wheels spaced 6 feet on axles and with two-thirds of the load on the rear axle. In designing the trusses the uniform live load may be safely assumed as follows: For spans less than 50 feet in length, 125 pounds per square foot of floor surface; for spans between 50 and 100 feet in length, 100 pounds per square foot of floor surface; while for spans greater than 100 feet in length, the assumed uniform live load per square foot of floor surface may be reduced 2 pounds for each additional 10 feet in length of span, provided that in no case should the assumed uniform live load be less than 80 pounds per square foot of floor surface.

Piers and Abutments

A large percentage of the bridge failures in this country have been due to improperly designed abutments. There seems to be a general tendency to confuse the design of abutments with that of piers, and it is not unusual to see a bridge, consisting of a single span, supported on four slender cylindrical piers with no other provision for restraining the material of the approach embankment than wooden boards resting against these piers. There can be no objection to the use of properly designed cylindrical piers for supporting intermediate spans; but the abutment must serve a dual purpose. It is required to support the bridge and also to act as a retaining wall for the approach; and both of these functions should be considered in making the design.

Foundations for Piers and Abutments

In designing piers and abutments, the size of the footings should usually depend on the character of the foundation material. Investigations should, therefore, be made in the vicinity of each pier or abutment before the design is completed. The foundation may be tested by sounding with rods, by boring with wood augers, by sinking pipes with water jets or by drilling with a percussion drill.

When the character of the foundation material has been determined, its safe bearing capacity may be estimated from the following table, taken from U. S. Office of Public Roads and Rural Engineering Bulletin No. 43.



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**WALLACE
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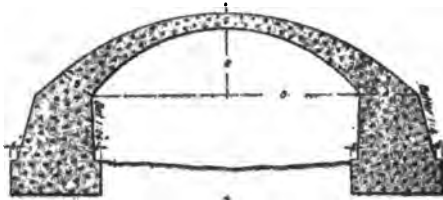
GENERAL NOTES

All work reinforcing steel of these surfaces of concrete shall be done in form, projection outside of side walls may be omitted and the rods at the bottom shall extend outside the other wall. Quantity in kg shall be by 1:2:4, all other concrete by kg 1:2:8.

**U.S. OFFICE OF PUBLIC ROADS.
REINFORCED CONCRETE**

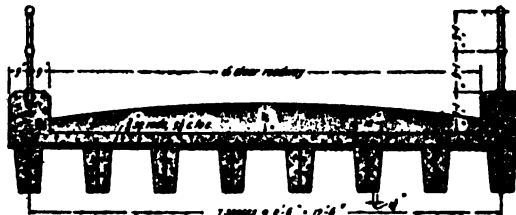
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TYPICAL SECTION PLAN CONCRETE ARCH
Concrete in superstructure 1:2:4. In abutments and wing walls 1:1 1/2:2. For intermediate spans, the dimensions may be obtained by interpolation.

Span + d	A	B	C	D
8'-0"	8'-0"	0'-5"	1'-0"	1'-0"
12'-0"	3'-0"	0'-8"	1'-2"	2'-2"
16'-0"	3'-0"	1'-1"	2'-0"	2'-3"
20'-0"	3'-6"	1'-6"	2'-3"	2'-6"



TYPICAL SECTION ENLARGED I-BEAM BRIDGE

Span	Slab 1	Slab 2	Slab 3	Span	Slab 7
12'	8'-0" H	12'	10'-0" H	20'	10'-0" H
16'	8'-0" H	16'	12'-0" H	24'	10'-0" H
20'	10'-0" H	20'	12'-0" H	28'	10'-0" H
24'	10'-0" H	24'	12'-0" H	32'	10'-0" H

Slab channels to be the lightest standard channels of the depth specified for the span. Concrete in superstructure 1:2:4.



TYPICAL SECTION REINFORCED CONCRETE T-BEAM BRIDGE

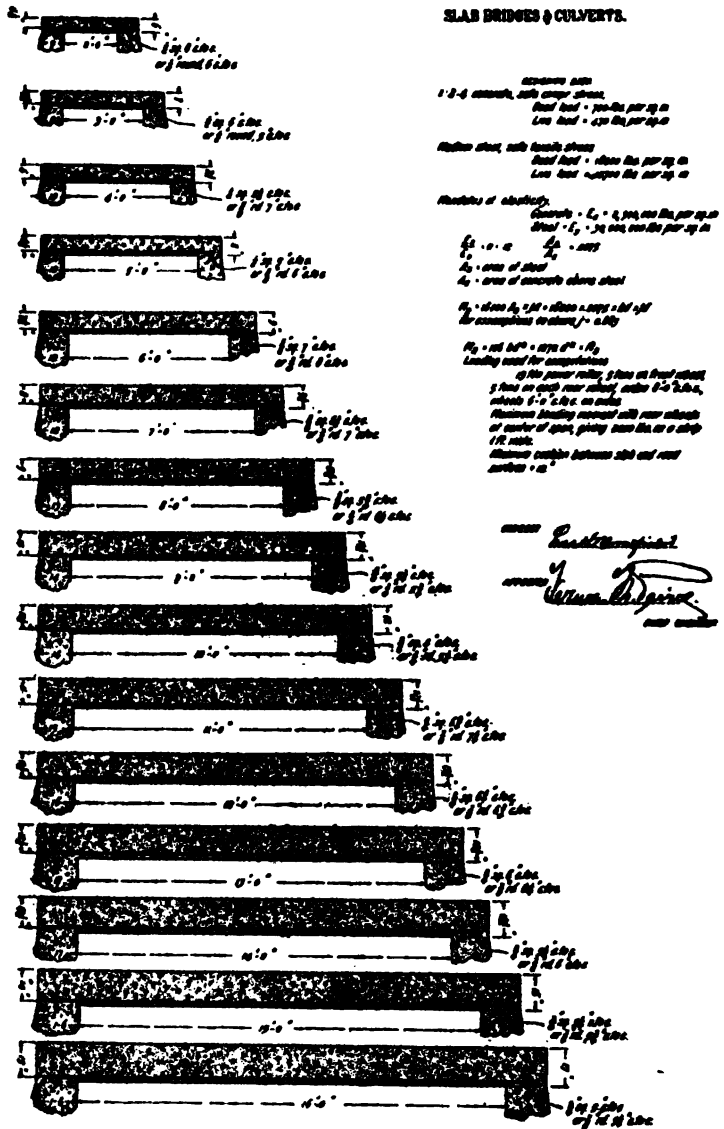
Concrete in superstructure 1:2:4.

U.S. OFFICE OF PUBLIC ROADS.

TYPICAL SECTIONS FOR SHORT SPAN CONCRETE BRIDGES.

DESIGNED BY *Robert M. Jones*
 DRAWN BY *James H. Jones*

U.S. OFFICE OF PUBLIC ROADS
TYPICAL SECTIONS FOR REINFORCED CONCRETE
SLAB BRIDGES & CULVERTS.



Note: All longitudinal rods 1/2" spaced at 12" x 12" or 16" x 16" spaced at 12" x 12".



Material	Bearing power (tons per square foot)	
Quicksand and wet soils.....	0.05	to 1
Dry earth.....	1	to 1 5
Moderately dry clay.....	2	to 4
Dry, stiff clay.....	4	to 6
Sand.....	2	to 4
Sand, compact and cemented.....	4	to 6
Gravel, cemented.....	8	to 10
Rock.....	200	

Where the material of the foundation is poor, as, for example, wet clay or quicksand, it is customary to increase its bearing power by making use of piles, which are driven to such depth as is necessary to prevent settling after the weight of the whole structure is superimposed, the piles being considered as carrying the entire load. The formula in most general use for determining the amount of driving necessary to produce this condition is that proposed by *Engineering News*, $P = \frac{2WH}{S+1}$, in which P is the safe load in pounds on one pile, W the weight of the hammer in pounds, H the fall of the hammer in feet, and S the penetration or sinking in inches under the last blow.

Floors

Highway bridge floors are made of wood, reinforced concrete or steel. Wood floors are probably the most common, but reinforced concrete presents many advantages over wood for this purpose, and is becoming very popular. Wood floors on old bridges, however, should never be replaced by concrete, unless the change was anticipated in the original design. Neither should the thickness of the wood floor be much increased, as any additional weight put on the structure for which provision has not been made is likely to prove disastrous.

The economical thickness of wood floors depends on traffic and climatic conditions, as well as on the quality of the wood. In general, it should be such that the wood will have practically worn out before being destroyed by decay. This economical thickness varies from 2½ to 4 inches.

Concrete or steel floors should always be protected from the traffic by cushion of earth or macadam.

Painting

Steel bridges should ordinarily be repainted about once every three years. If this work is neglected, as is so frequently the case, rust soon makes inroads into the metal, impairing both its strength and appearance.

Concrete Bridges and Culverts

Concrete bridges and culverts should be designed to sustain the same live loads as those indicated above for steel bridges.

The proper type of superstructure to adopt for any particular case should usually depend on local conditions. For example, where sufficient head room and satisfactory foundation can be obtained, an arch may be advantageously used. Where head room is limited or the foundation poor, however, it may frequently be necessary to make the superstructure flat. Also, flat slab superstructures are ordinarily used for spans less than about 14 feet in length, as little, if any, saving can be effected by using an arch. Where appearances are of prime consideration, however, an arch may properly be used, even at additional cost.

There are three types of flat reinforced concrete superstructures in general use which are respectively known as the slab type, the encased I-beam type, and the T-beam type. Each of these types may be used with either stone or concrete abutments.

The slab type is practicable only for spans less than about 16 feet in length. Culverts and bridges of this type are very easily constructed, and require very little skilled labor.

The encased I-beam type of superstructure is well suited for spans from 10 feet to 30 feet in length. In this type, the steel beams are designed to carry the entire load, though the concrete casing undoubtedly increases the strength of the structure.

The T-beam type is adapted for about the same range of spans as the I-beam type, though T-beams can be used for somewhat longer spans. When used for spans over 30 feet in length, however, the economy of employing them should be demonstrated for each particular case. The construction of T-beam bridges and culverts is more difficult than either of the other types and requires more skilled labor. The cost of materials, however, is, in general, somewhat less.

The illustrations on pages 234 to 237, which were prepared from data contained in Bulletin No. 45 of the U. S. Office of Public Roads, show how the various types of concrete superstructures are designed, and also show typical designs for a 4 foot by 3 foot box culvert, and a 10 foot span slab bridge on stone abutments.

Pipe Culverts

Vitrified clay, cast iron, corrugated iron, steel plate and concrete pipes are used for the smaller culverts. Up to 24 inches in diameter pipe culverts are usually economical and the pipes are easily handled and laid. They should be laid true to grade and on a firm foundation. Headwalls of concrete, brick or stone should be constructed at each end, extending high enough to carry the fill and low enough to avoid damage by frost.

Cast Iron Pipe Culverts

Cast iron pipe has been satisfactorily used for culverts for many years, and while not as cheap per foot, nor as easily handled as some of the lighter metal culverts, its claim to durability can not be questioned. Some of the cast iron pipe culverts placed in Paris over three hundred years ago are still in service and apparently in a fair state of preservation.

Cast iron pipe for highway culverts is usually made in 12-foot lengths, and can be obtained in various diameters from foundries in almost every part of the country.

Sectional Cast Iron Culverts

The sectional cast iron culverts possess features which tend to make them desirable in highway work. With their flattened oval base, they are said to have greater freedom from clogging. Their locked joints hold them intact. It is claimed that their headwalls hold the roadbed in shape thus allowing a shorter length of culvert to be used. It is also claimed that their form gives them greater strength than the round structures possess, as well as facilitates easy handling and consequent saving in transportation and that they may be assembled by unskilled labor. They make good culverts for highways.

Corrugated Metal Culverts

Many culverts are now being constructed of corrugated galvanized iron or steel sheets. The corrugations are designed to so strengthen the sheet as to reduce the danger of collapse. This form of culvert has come into extended use during the past eight or ten years largely on account of the fact that it is easily installed and does not require the close supervision which is necessary for many other types of highway drainage.

The pipe should, however, be made to conform to proper requirements for fabrication, riveting, etc.; should be made from a sufficiently heavy gauge of metal to insure strength for the diameter of pipe required; and should be sufficiently and properly galvanized. In the best practice, such culverts are installed with concrete or masonry headwalls.

Vitrified Clay Culvert Pipe

In localities where the ground does not freeze to great depths, vitrified clay pipe has proved satisfactory as a culvert material. It should be double strength, hard burned, and salt glazed. Each pipe should be a true cylinder, free from cracks, and have a thickness of shell of at least one-twelfth of the internal diameter. In

laying the culvert, care should be taken to round out the bottom of the ditch to fit the pipe, making suitable depressions for the bells. Where rock occurs in the ditch, it should be excavated some 6 inches below the lower surface of the pipe and replaced with clay or sand. In very cold climates, the pipe should be completely covered with sand or broken stone for a depth of at least 6 inches. Where earth comes directly in contact with the pipe, danger from freezing is considerably increased. The surface of the roadway should never be less than $1\frac{1}{2}$ diameters above the top surface of the pipe.

Importance of Engineering Supervision

Before leaving the subject of bridges and culverts, attention should be called to the importance of having the design and construction of all such structures executed under the immediate supervision of a competent engineer. In no other feature of highway improvement can technical training be employed to better advantage. Not only the efficiency of the structure itself is involved, but human safety is not infrequently dependent on its proper design and construction.

PATENTED METHODS OF ROAD CONSTRUCTION

All manufacturers of road materials were requested to submit descriptions of any patented methods of road construction which they thought should properly be included in this chapter. The information contained herein is based upon the replies received.

Bitulithic Pavement.—This pavement is laid under several patents, the basic principal United States patent being No. 727,505, issued to the late Frederick John Warren. The scope of the patent as given in the opinion in Warren Brothers Company vs. Owosso, Michigan, written by Mr. Justice Lurton, then Presiding Justice of the United States Circuit Court of Appeals, Sixth Circuit, is as follows:

Warren's invention, shortly stated, consists in the discovery that an aggregate of large and small pieces of stone, together with a certain proportion of stone dust, all mixed together and thoroughly permeated with bitumen or asphalt, results, when set, in a compact, stable structure, is less liable to disintegrate from traffic or weather than any other method of grading or arranging the mineral constituents. Under the evidence, the particles are more compact in their relation to each other and there is a minimum of friction in their interaction. The larger pieces of stone withstand the tendency of the small grains or dust to slip by each other and change the form of the pavement by disintegration and lumpy spots. The result is, therefore, a stability due to the arrangement of the mineral structure which enables the use of a softer asphalt or bitumen than would be otherwise feasible, inasmuch as a greater proportion of the wear and strain is carried by the mineral elements than by the binding constituent.

The Bitulithic surface may be laid on any suitable substantial foundation, such as macadam, new or old; crushed stone properly compressed; concrete, either new or resurfacing foundations of old pavements; old brick; granite block or cobble stones. Bitulithic surface is described by the owners of the patents as follows:

Surface: Upon the foundation is spread the wearing surface which is compressed with a heavy road roller to a thickness of 2 inches. The surface mixture is made of the best stone obtainable, varying in size from a maximum of 1 inch or 1½ inches down to an impalpable powder, the various sizes of smaller stone, sand and impalpable powder being provided to fill the spaces between the larger stones. The proportions used of the various sizes of mineral are pre-determined by physical tests with a view to obtaining the smallest percentage of air spaces or voids in the mineral mixture, and vary with the character and shape of particles of the stone used in each particular case. After the proportions have been determined, the mineral material is passed through a rotary dryer, from which it is

carried up an elevator and through a rotary screen which separates the mineral material into its several different groups of sizes. The proper proportion by weight of each of these sizes is secured by the use of a scale having seven beams, the exact required amount being weighed out, and run into a double shaft rotary mixer. There it is combined with a bituminous cement which is also accurately weighed in the proper portion. The whole is then thoroughly mixed together and dumped, while still hot, into carts, hauled to the street and spread and thoroughly rolled with heavy steam road rollers.

Grit Surface: After the surface is thoroughly rolled, a flush coat of quick drying bituminous cement is applied to the surface, thoroughly sealing it and increasing its waterproofness. There is then applied a thin layer of finely crushed stone, varying from $\frac{1}{4}$ -inch to $\frac{1}{2}$ of an inch in size, according to the roughness of the surface desired. The pavement is again thoroughly rolled, leaving the street in a finished condition.

Warrenite Road.—Warrenite Road is a modification of Bitulithic pavement adapted to meet the traffic conditions which exist on country highways.

Bitustone Double Bond Roadway.—This is laid under United States patent No. 1,001,695 issued to August E. Schutte of Northboro, Mass., on August 29, 1911. The construction is briefly described by the eighth claim of the patent, as follows:

A pavement for foot or vehicular traffic, comprising a mineral aggregate the particles of which are in substantial contact and are otherwise surrounded and bonded together by a rigid non-liquefiable cement, the voids between the bonded mineral particles being filled with elastic cement.

The total depth of the construction recommended by the patentee is 5 inches, as follows:

1. Foundation or Bottom Course; of ordinary Portland cement concrete, the mineral aggregate of which may be either crushed stone, gravel, slag or other suitable material.

2. Bonding Course; of hard stone or gravel, of nearly uniform size, varying from about 1 inch to $\frac{1}{2}$ inch mixed with neat Portland cement in the proportion of one part cement to six parts stone. The bonding course is tamped and well embedded into the mortar of the foundation or bottom course.

3. Filler; after the bonding course is thoroughly set, presenting particles of crushed stone strongly united with neat Portland cement, but containing a large percentage of voids between the individual particles, hot bituminous cement especially prepared for the purpose, is flushed over and penetrates into the spaces of the bonding course, and while the cement is still hot the whole surface is covered with fine crusher screenings or coarse sand.

Hassam Pavement.—Upon a well compacted subgrade is spread not less than 5 inches of broken stone in sizes varying from $1\frac{1}{2}$ inches to $2\frac{1}{2}$ inches in diameter. The stone must be clean and fresh with no dirt. After this is rolled and brought to desired cross section the compressed stone is thoroughly grouted. The

grout consists of two parts of sand to one or more parts of Portland cement. This grouting is done with a Hassam patent grout mixer driven by a gasoline engine. Before the initial set takes place and during the process of grouting the road is thoroughly rolled. Upon the top of the pavement is then spread a thin layer of pea stone which is also rolled. The Hassam Paving Company, Worcester, Mass.

Patented Materials for Road Construction in which the Method of Construction is not Patented

To provide information concerning materials the *preparation* of which involves a patent but which are not patented as to their method of *application*, a letter was sent to all road material manufacturers asking them to submit specifications or other suitable material for a special chapter to cover these conditions. The following reports comprise all that have been received:

Amiesite.—A paving material, the ingredients of which are incorporated into a paving mass under patents issued to Joseph Hay Amies and Warren Brothers Company. It consists of the best grade of crushed stone or gravel, graded in sizes from $1\frac{1}{2}$ to $\frac{1}{4}$ inch (as to give the inherent stability required for a permanent road), chemically treated before applying the asphalt and other material required for the finished product. The stone is then coated, without heating, with an asphaltic cement, composed of refined asphalt containing not less than 98 per cent bitumen and other ingredients. The run-of-the-crusher Amiesite is to be used in the first course; the second course is either $\frac{1}{2}$ or $\frac{1}{4}$ -inch stone, treated in the same manner except it requires additional asphalt per ton of Amiesite, known as "Amiesite Filler." The material is shipped to destination ready for immediate use, without further treatment. By way of summary, it may be stated that the ingredients of Amiesite are crushed stone, asphalt, lime and naphtha.

Fibred Asphalt Pavement.—This pavement is laid under several patents, its basic principles involved being covered by United States patent 1040321, applied for April 8, 1911, and issued its patentee, George A. Henderson, of St. Albans, W. Va., on October 8, 1912. The invention relates principally to the art of denaturing hard-wood and preserving it in the following manner: a billet of hard-wood is shredded into small particles of un-uniform lengths of $1\frac{1}{2}$ inches down to wood flour, the flour itself being eliminated from the aggregate by screening. The particles are denatured by the process used by the tannin extract manufacturers, in which process all sap, essence and the more evaporable and deteriable elements in the wood are extracted, the remaining particles being thereby rendered abnormally enlarged and porous. In their sub-

sequently dried and heated condition the wood particles, because of their porosity, are susceptible of impregnation, by absorption, by a non-deteriable, non-evaporating matter (such as asphalt), in lieu of the sap, etc., removed. The heating of the dried particles, to prevent the premature congealing of the molten asphalt before reaching the particles' pores, has also for its object the partial contracting of the enlarged particles. The consequent contraction in the size of the particles' pores correspondingly reduces the amount of asphalt required to completely fill them.

The wood fiber is a waste product of tannin extract manufacturers, who use hard-wood and no bark in their process. The particles are taken from the leaches on endless belts; dried, screened, heated and then mechanically mixed with a predetermined uniform percentage of asphalt, sufficient to fill the pores and voids in the mass when finally contracted and compressed. The material, in its partially impregnated and partially contracted condition is deposited at the mouth of its mixer into moulds 4 by 6 feet, these blocks being compressed on all sides only 3 to 4 inches, and allowed to cool, when they will remain intact for shipment, but are readily disintegrated in a breaker stationed at the front of a portable reheating machine, designed to travel over the road to be paved, in which machine the coated particles are deposited and heated to from 250 to 275° F. This heating results in the final contraction of the fiber to its normal size, as it was before being chipped from its original log, and the entrapping of its asphalt content, thereby insuring penetration to the most minute pore of the fiber, thus thoroughly preserving it, without affecting its natural resiliency. The mass emerges from the rear of the reheating machine in a continuous 18-inch flow on to the previously prepared road base, where it is mechanically spread 4 inches thick, steam roller compression immediately reducing it to a compact mass 2 inches thick. The interlocking of the un-uniform preserved sinews of the hard-wood, in conjunction with the substantial penetration of the binding asphalt, in addition to surrounding the particles, is relied upon for durability.

Fibred asphalt may be laid on any substantial foundation such as old macadam, crushed stone, concrete, old brick, granite or wood blocks or cobble stones. For use on country roads a curb or shoulder is not necessary.

Westrumite.—The patents in connection with Westrumite asphalt pavement protect the emulsifying of the asphaltum. There are also several independent companies in the United States, Canada and Europe manufacturing and marketing Westrumite.

Westrumite is an asphaltic cement, temporarily liquefied by emulsification. It is shipped in tight barrels and without any further preparation is mixed *cold* with the proper stone matter in an

ordinary concrete mixer, is laid on any suitable foundation and thoroughly compacted, with a five to eight ton roller. The evaporation of the vehicle leaves the asphaltic cement as the binder.

There are two principle types of construction. The first is the mixing process or asphaltic concrete construction, using hard suitable crushed stone of two sizes, namely: $\frac{3}{4}$ inch to $\frac{1}{2}$ inch and $\frac{1}{2}$ inch to and including dust. The latter especially is carefully tested and made to conform to specifications designed to give the greatest density. The mixture of the stone and the quantity of Westrumite are ascertained by a determination of the voids in the stone matter. After the surface is thoroughly compacted a flushing coat is used to fill any small voids or roughness on the surface and the whole is again thoroughly rolled. The surface thickness is $1\frac{1}{2}$ inches for light traffic and 2 inches for heavy traffic.

The other principal type of construction is the combination of the mixing and penetration methods. Crushed stone ranging in size from 2 inches to 1 inch, after being thoroughly coated with Westrumite asphalt, is spread on any suitable foundation to make a wearing surface of at least 2 inches thickness after rolling. This stone course is not compacted. A second course composed of Westrumite asphalt and crushed stone from $\frac{1}{2}$ inch to and including dust, in proper proportion, is then spread over the coarse stone in sufficient amount to thoroughly fill all the voids. The liquid consistency of this mortar causes it to penetrate and fill the voids of the coarse stone. This process is assisted by the pressure of the roller. The seal coat is also applied in this construction.

Recently another type of construction has come into use which is a bituminous carpet of $\frac{1}{2}$ inch thickness on concrete roads. This carpet is composed of Westrumite asphalt, mixed cold in an ordinary concrete mixer, with stone matter ranging from $\frac{1}{2}$ inch to and including dust, properly graded. This mixture is spread on the concrete surface to a uniform depth of $\frac{1}{2}$ inch by means of a templet. Owing to the fact that Westrumite asphaltic cement is an aqueous emulsion the adhesion to even damp concrete surfaces is perfect.

National Pavement. This product is manufactured under United States patent No. 1008433 issued to Michael A. Popkess of Kansas City, Missouri, which covers the material as well as the process of producing the same. It is impossible to produce National pavement with the machinery used in manufacturing any other type of bituminous material.

A machine was designed by and patent No. 1062552 issued to Michael A. Popkess. Later improvements were made on the machine for which patents are pending.

National pavement is composed substantially of absorbent earthy material mixed with a liquified bituminous binder, the

earthy material being previously disintegrated to such a degree of fineness as to render it capable of absorbing and combining with the binder to form a coherent homogeneous dense, yet malleable substance.

The process, as carried out in its manufacture, consists in taking ordinary clay, loam or soil, subjecting it to a disintegrating treatment in a drum containing means to pulverize in the presence of heat, which simultaneous action of the heat and attrition reduces the material to a fine, dry, hot dust, which is collected and mixed in even quantities. The mixture 2 to 3 inches in thickness is spread upon a well compacted and properly drained earth base and rolled.

A good soft grade of asphalt is used to waterproof and bind the fine earth dust together, which mixed material naturally compacts together under the roller, producing a dense and malleable pavement for street and highway use, substantially free from voids.

DIGEST OF STATE HIGHWAY SPECIFICATIONS

One of the objects of the American Association of State Highway Officials is to bring about more uniformity in the technical requirements of specifications for the same classes of road work. The present absence of any standard is apparent from an examination of the specifications of different States where a large amount of work is carried on annually. Although the differences in some cases are more verbal than technical, this is not true in all instances, and the Association hopes to bring about marked improvements through cooperation among its members. In the following digest, the numbers expressing grades of materials apply only to the State under consideration, as there is no uniformity in nomenclature.

Water-bound Macadam and Telford Roads

Telford base.—New York requires field or quarry stone of approximately rectangular shape, not less than $1\frac{1}{2}$ inches thick, as deep as the depth of the base and not over $1\frac{1}{2}$ times the depth in length. No projections over 1 inch above the established surface grade are permitted. The base must be rolled with a roller weighing 10 tons or more, its interstices filled with screenings, and then rolled again.

New Jersey requires stone between 5 and 10 inches long, 2 and 4 inches wide, and at least 6 inches deep. These are wedged with spalls before any rolling is done. After rolling, screenings, gravel or sand is spread over the surface and rolling resumed; this is continued until all interstices are filled with the binder, but the latter is not permitted to form a coating on the surface.

Macadam bottom course.—New York provides three types. (1) Run-of-bank gravel passing a $3\frac{1}{2}$ -inch circular hole, with the material passing a $\frac{1}{4}$ -inch screen not exceeding by over 5 per cent the voids in the remaining material after its separation. No segregation of large and fine materials is permitted in the gravel when in place. (2) Screened gravel, and (3) broken stone; the specifications call for graded No. 3 ($1\frac{1}{4}$ to $2\frac{1}{4}$ inch) or No. 4 ($2\frac{1}{4}$ to $3\frac{1}{4}$ inch) material, or a uniform mixture of the two, and the engineer may permit the use of a small amount of No. 2 ($\frac{3}{8}$ to $1\frac{1}{4}$ inch) material. Where the finished bottom course is over 5 inches thick

it must be placed in two separate layers. Rolling must be done with roller weighing at least 10 tons, beginning at the sides and shifting toward the center, and must be continued until there is no disturbance of the stone ahead of the roller. The surface is then covered with stone or gravel from $\frac{1}{4}$ to $\frac{3}{4}$ inch in size and screenings or sand, which are swept into the interstices. The course is then rolled dry. Where the bottom course is placed in two layers, each layer has small stone worked into it.

New Jersey specifications provide for several types. In the first the bottom course is $2\frac{1}{2}$ -inch stone rolled with a 10-ton roller with at least 400 pounds per linear inch on the drivers. This surface is covered with not over 1 inch of screenings, gravel or sand, which is rolled into the stone until there are no loose places. The binder must be dumped on the shoulders and then spread on the stone. (2) The bottom course consists of hard, tough field stone, passing a 5-inch ring and held on a 3-inch ring, no dimension exceeding 7 inches. This is rolled, binder added, and rerolled, until it is firm. (3) Gravel approved by the engineer may be used; it must be rolled, scraped and watered as he directs.

Maryland specifications call for sound stone or slag, 1 to 3 inches in size, or gravel up to $2\frac{1}{2}$ inches in size with not more than 25 per cent passing a $\frac{1}{4}$ -inch screen. No material may be dumped on the road-bed, and no layer may exceed 6 inches before rolling, which must be done with a 10-ton roller. The engineer may permit some water and sand to be used to aid the consolidation. The engineer may require the contractor to remove the stone or gravel from places where sub-grade material has worked up into the stone or gravel.

Ohio specifications permit the use of gravel, sandstone, limestone, slag, vitrified clay, boulders or field stone. Sandstone pieces must not be longer than 6 inches; the other materials must be broken to No. 1, No. 2, or No. 23 Ohio standard sizes, which must be harrowed after spreading. The roller must weigh 10 to 13 tons, have three wheels, a maximum rolling width of 84 inches, and the drivers exert an average compression of at least 350 pounds per linear inch. The course must be rolled dry until keyed together. Then "sufficient water shall be applied, rolling continued and screenings added until the stones cease to sink or move in front of the roller." An old macadam or gravel road may be used for a foundation, if satisfactory to the engineer.

The Illinois specifications provide only for gravel roads among water-bound types. The bottom course is raked to bring the largest stones to the bottom and then rolled with a three-wheel roller weighing at least 300 pounds per linear inch of wheel. The gravel must be wet when rolled, and the speed of the roller is

limited to 100 feet per minute. The bottom course must be left firm and smooth.

Gravel top course.—New York specifications permit run-of-bank gravel only where the engineer consents in writing to its use. Gravel of $1\frac{1}{4}$ to $2\frac{1}{4}$ inch size is required, but the engineer may permit a certain amount of $\frac{3}{4}$ to $1\frac{1}{4}$ -inch material to be mixed with the larger size. The binder for screened gravel must be a mixture of the sand screened out of the gravel and the $\frac{3}{4}$ to $1\frac{1}{4}$ -inch material, with not over 17 per cent of clay added when desired. The binder is swept into the interstices of the top course, which is then sprinkled and rolled with a 10 to 12-ton roller, the addition of binder and the sprinkling and rolling being continued until the course is compacted. Where run-of-bank gravel is used, it must meet the requirements for bottom course gravel; the binder required is the fine material from the bank, to which the engineer may allow a small amount of clay or loam to be added.

The New Jersey requirements for top-course gravel are stated under "Materials." The material must be harrowed and then rolled and scraped until satisfactory to the engineer. The engineer may allow a horse roller to be used. These specifications also permit a bottom course of shells, 12 inches thick at the center and 8 inches at the shoulders before consolidation. These shells are covered with 2 inches of gravel, and empty wagons are then driven over the road and it is kept shaped with a scraper until it is hard. The final thickness must be at least half the thickness of the shells and gravel applied.

The Illinois specifications for a second course of gravel call for the admixture of binder gravel with the road gravel, if required by the engineer. The binder gravel is spread on the road gravel after the latter has been rolled with a three-wheel roller weighing at least 300 pounds per linear inch of wheel, and is wet and rolled until the surface is hard and shows no tracks.

Broken stone top course.—New York requires stone $1\frac{1}{4}$ to $2\frac{1}{4}$ inches in size and a binder consisting of screenings and $\frac{1}{2}$ to $\frac{3}{4}$ -inch stone. No stone may be dumped into place in mass; the final placing must be by shovel or by spreading thin without appreciable fall. It is rolled with a 10 to 12-ton roller until there is no wave ahead of the roller. Binder is then thrown on the surface with shovels, so as to form a light coat, which is swept into the stone, and another rolling given. This dry work is continued until no more binder will enter the stone, after which the macadam is sprinkled until saturated, the sprinkler being followed by the roller. More screenings are added where necessary, and the sweeping, sprinkling and rolling continued until a grout is formed which fills all interstices and forms a wave ahead of the roller.

The top course is covered with screenings to a depth of at least $\frac{3}{4}$ inch.

New Jersey requires $1\frac{1}{2}$ -inch stone, rolled until settled. It is then covered with binder and rolled, and these steps are continued alternately until the voids are filled with binder. Water is then sprinkled and the surface rolled until there is a wave ahead of the roller. A 10-ton roller applying a load of 400 pounds per linear inch of driver is required. When the rolling and sprinkling have thoroughly consolidated the course, and all depressions that develop have been filled with well rolled $1\frac{1}{2}$ -inch or $\frac{3}{4}$ -inch stone and screenings, the surface is covered with a mixture of equal parts of $\frac{3}{4}$ -inch stone and screenings, which is rolled until the road becomes hard and smooth. The use of water in this work is subject to the control of the engineer.

Maryland specifications call for stone 1 to 2 inches in size, no dimension to exceed 2 inches. Trap rock must have a coefficient of wear of at least 12 and limestone a coefficient of at least 10. It must be consolidated with a 10-ton roller and watering and sprinkling may be permitted by the engineer. This course is 3 inches thick after rolling. The surface is covered with trap rock screenings varying from dust to 1-inch pieces. Other material may be used with the engineer's permission, but limestone screenings may not be used with a limestone second course except with the written consent of the engineer or approved clean sand is used in equal parts with the limestone screenings. The screenings are rolled dry, then sprinkled, and rerolled. This is continued until water flushes to the surface.

Ohio specifications call for No. 1 stone or slag, harrowed, and rolled dry until it ceases to sink or move under the roller. The rolling must begin with the outer driver covering equal strips of the shoulder and stone; the roller must run over these strips until they are firmly bound together, and then work gradually toward the center. No. 5 or No. 7 screenings are applied gradually while the dry rolling is being finished. They must be cast in a thin layer with shovels and enough used to fill all interstices; the engineer may require them to be swept into the voids. When no more screenings can be forced into the voids, the road is wet with a sprinkler, which is followed by a roller, and more screenings are added if they can be incorporated in the road. The sprinkling, sweeping and rolling are continued until a grout of water and screenings forms a wave ahead of the roller. The macadam must be kept wet at least 24 hours before the final rolling. The road is not used until thoroughly dried.

Bituminous Roads, Penetration Method

Bottom course.—Massachusetts specifications for asphalt penetration roads call for a mixture of No. 1 and No. 2 stone in proportions directed by the engineer. After rolling, this course must be 2 inches thick at the sides and 3 inches thick at the center, except over stone filling, where it is uniformly 2 inches thick. The course is then covered with screenings and rolled dry until the screenings are just below the top of the broken stone. For tar-grouted roads the bottom course is made 4 inches thick at the center. The binder for the lower course in this class of roads is clean, sharp material free from loam and clay and must pass a $\frac{1}{2}$ -inch mesh and be caught on a screen with 30 meshes to the inch.

New York, Ohio and Illinois specifications call for substantially the same bottom course as for water-bound macadam.

Top course.—The Massachusetts specifications call for a course of No. 1 stone, 2 inches thick after rolling. The binder used in one class of work is asphalt, supplied by the commission. It must be at approximately 300° F. when applied and must be "uniformly applied by a pressure machine (equipped with an air compressor for applying the asphalt by direct pressure) at the rate of 1 $\frac{1}{4}$ gallons" per square yard. The treated surface must then be covered with enough clean pea stone to fill the surface voids and permit the steam roller to pass over it without sticking to the asphalt. The pea stone is spread with brooms. After the road has been thoroughly rolled, the surplus pea stone is swept off and asphalt is applied by a pressure machine at the rate of $\frac{1}{2}$ gallon per square yard. A coating of pea stone is then spread and rolled. No bituminous work is permitted in rainy weather or under other conditions considered unsatisfactory by the engineer, and the stone must be perfectly dry before applying the asphalt. For tar-grouted roads the specifications are much the same, except that the tar must be used at 200° F.

New York specifications are substantially the same as those of Massachusetts, except that there is no standard thickness. No. 3 stone is specified. Asphalt must be at 250° to 350° F. and tar at 200° to 250° F. The first application is at the rate of 1 $\frac{1}{4}$ gallons per square yard for a 3-inch top course "with a proportional reduction in the quantity for thinner courses." No. 2 stone is used for surfacing after the first application and No. 1 stone after the second application of asphalt or tar, which is at the rate of $\frac{1}{2}$ gallon per square yard.

Illinois uses 2 $\frac{1}{4}$ -inch stone harrowed, rolled and then covered with bituminous material at the rate of 1 gallon per square yard. Screenings are swept over the surface until the surface voids are filled and the surplus is removed. Bituminous material is then

applied at the rate of $\frac{1}{2}$ gallon per yard and covered with torpedo gravel, which is brushed into the surface and the surplus swept away. A third coat of bituminous material is then applied at the rate of $\frac{1}{2}$ gallon per square yard and covered with torpedo gravel, at the rate of 1 cubic yard per 200 square yards. The surface is then rolled, the wheels being wet to prevent sticking.

Ohio specifications call for No. 2 stone for a top course less than 3 inches thick and No. 1 stone for a course of 3 inches or more. Slag may be used. Where the course is over 3 inches thick when finished, the bottom voids to within 3 inches of the surface must be filled with coarse sand or screenings, by harrowing. The surface must be rolled and harrowed until it is free from dust and does not sink under the roller. The amount of bituminous material for the first application is not fixed in the standard specifications. The material may be applied by pressure distributors or hand sprinkling pots, and is covered with No. 4 grit swept into the interstices. The road is then rolled until hard, all loose grit is swept off and a seal coat of bituminous material applied at the rate of $\frac{1}{2}$ gallon per square yard. The surface is covered with No. 4 or No. 6 grit at the rate of about 1 cubic yard to 70 square yards of surface, and thoroughly rolled.

Bituminous Roads, Mixing Method

Bottom course.—Massachusetts requires a course uniformly 4 inches thick after rolling, of stone $\frac{1}{2}$ to 3 inches in size. The surface is covered with screenings which are swept into the interstices, none being left on the surface. The engineer may direct the course to be watered.

New York specifies a bottom course of concrete, broken stone, quarry or field stone, or gravel. Some of these were described under "Water-bound Macadam."

Illinois requires 3-inch stone, rolled thoroughly and covered with screenings as in Massachusetts.

Maryland requires a concrete foundation for bituminous concrete.

Top course.—Massachusetts specifies a 2-inch finished course. The sand must pass a $\frac{1}{4}$ -inch mesh and be clean. The gravel or stone must be $\frac{1}{2}$ to $1\frac{1}{2}$ inches in size. Crusher screenings are permitted. The sand and stone must be from 15 to 75 per cent of the whole aggregate. The aggregate is heated to at least 180° F. and then mixed by machinery with asphalt heated to at least 200° F. The asphalt is furnished by the State and the quantity to be used is decided by the engineer. The mixture must be used before its temperature is below 100° F.; it must be dumped on steel platforms or shoveled from the carts. It is spread with

rakes and at once rolled with a tandem roller weighing not less than 7 tons. Travel is kept off the finished surface for 24 hours.

New York has specifications for two types of top course. Type 1 uses No. 2 stone when the course is not over 2 inches thick and a mixture of No. 2 and No. 3 sizes with thicker courses. The sealing coat is No. 1 stone. Gravel may be used for broken stone. The stone must be heated to between 225° and 300° F. in a revolving dryer. If asphalt is used it must be heated to 275° F. and not over 350° F. If tar is used it must be heated 200° F. and not over 275° F. About 18 gallons of bituminous material are used per cubic yard of loose stone; the amount of bituminous material in the completed course must be from 5 to 7½ per cent. A revolving blade mixer with heating facilities is specified, and the mixing must continue until every stone is coated. The temperature of the finished mixture must be 200° to 300° F. for asphalt and 200° to 250° F. for tar. After rolling, the surface is to have a seal coat of asphalt applied at the rate of ½ to ¾ gallon per square yard by a pressure distributor. This must be covered at once with No. 1 stone and rolled. Before the seal coat is applied all depressions exceeding ½ inch, as shown by a 10-foot straight edge, must be eliminated. The roller must weigh 8 to 10 tons and give a compression of 200 to 350 pounds per linear inch of rear wheel. Type 2 top course is a mixture of 7 to 11 per cent of asphalt, 5 to 11 per cent of aggregate passing a 200-mesh screen, 18 to 30 per cent passing a 40-mesh screen, 25 to 55 per cent passing a 10-mesh screen, 8 to 22 per cent passing a 4-mesh screen and less than 10 per cent passing a 2-mesh screen. After this mixture has been laid, rolled and thoroughly dried, it is covered with enough Portland cement to form a film over the whole surface.

In New Jersey the standard specifications provide for a large variety of single and double course bituminous concrete pavements; where two courses are used the lower is a binder course. The requirements for single course pavements all call for a 2-inch finished course weighing 250 pounds per square yard exclusive of the seal coat. The bitumen must be heated to 250° to 325° F. before mixing in each case, but the temperature requirements for the aggregate and the finished mixture vary. The seal coat is applied at 250° to 325° F., only enough being used to flush the surface voids; it is covered with clean screenings or coarse sand. The other requirements are given in the table on the next page.

In Maryland one type of bituminous concrete is that termed type 2 in the New York specifications. Another type consists of about 57 to 59 per cent of ½ to 1¼-inch stone 7 per cent of ¼

inch to 20-mesh sand, 21 per cent of 20 to 80-mesh sand, 6 per cent of sand and filler passing an 80-mesh sieve, and 7 to 9 per cent of asphalt. The aggregate and asphalt are heated separately to 250° to 350° F. and then mixed mechanically. The mixture must be at least 220° when hauled away. A tandem roller weighing 7 tons must be used. A seal coat at a temperature of 200° to 350° is spread "without leaving an excess," and then covered with torpedo sand or $\frac{1}{4}$ -inch chips and rolled until this fine aggregate is incorporated into the wearing surface.

New Jersey Requirements for Single-Course Bituminous Concrete Pavements

TYPE	D	T*	W
Aggregate, percentage			
2-1 inch.....	0-10		0-15
1- $\frac{1}{2}$ inch.....	38-45		40-50
$\frac{1}{2}$ - $\frac{1}{4}$ inch.....	12-18		10-25
$\frac{1}{4}$ inch-10 mesh.....		55	
$\frac{1}{4}$ inch-10 mesh.....	12-18		8-15
10-30 mesh.....	10-15	7.5	8-15
30-80 mesh.....	12-18	15.5-18.5	12-22
80-200 mesh.....	6-10	6.5-9.5	3-8
Passing 200 mesh, maximum.....	4-7	3.5	2-8
Bitumen, percentage.....	7-8.5	8.5	7-8.5
Temperature aggregate, degs. F.....	225-325	250-315	225-325
Temperature finished mixture on road, degs. F.....	225	240	225
Mixture rejected below, degs. F.....	215	225	215

* The specifications call for 550 pounds of $\frac{1}{4}$ -inch stone, 310 pounds of bituminous sand, 55 pounds of filler and 85 pounds of asphalt cement in a batch. The percentages in the table have been estimated from the specifications for these materials.

The Illinois specifications call for a mixture of 3 cubic yards of $1\frac{1}{4}$ -inch stone or 1-inch gravel, 1 cubic yard of grit sand and 81 to 90 gallons of bituminous material. The materials are heated to 300° to 375°, and the mixture leaves the mixer at 250° to 335°, according to the asphalt used. The lowest temperature of the surface mixture when spread is 230° to 280°, according to the asphalt used. After the initial rolling, a small amount of cement is swept over the surface; a roller weighing at least 300 pounds per inch of tread is required and the rate must not exceed 200 square yards per hour. The seal coat is applied at the rate of $\frac{1}{4}$ to $\frac{1}{2}$ gallon per square yard and covered with just enough grit sand to prevent the material sticking to the roller.

Brick Roads

Bottom course.—Cement specifications are the same everywhere.

New York specifies a $1 : 2\frac{1}{2} : 5$ mix. The sand must not contain over 8 per cent loam and silt and made into $1 : 3$ mortar must develop 80 per cent of the compressive strength of similar mortar of the same age made with standard Ottawa sand. No. 2 or No. 3 stone or gravel may be used. Proportions may be varied slightly to secure greatest density. Machine mixing required; at least 12 revolutions specified. No work to be done when temperature falls below 35° F. Surface of concrete must be kept moist and covered 7 days.

New Jersey standard specifications do not prescribe the mix, which is determined for each contract. Broken stone, gravel and slag are permitted. Machine mixing required. Concrete must be kept moist and covered 5 days and travel kept off for 10 to 15 days, according to the season.

In Maryland the mix is $1 : 3 : 6$. The sand must not have over 5 per cent of loam or earth. The broken stone or gravel must be $\frac{1}{2}$ to 3 inches in size with at least 50 per cent smaller than $1\frac{1}{2}$ inches in longest dimension. Machine mixing is optional. Surface must be kept covered and wet until the concrete has set, and travel must be kept off 7 days.

Ohio permits the use of "a thoroughly consolidated old macadam or gravel road, if of sufficient depth" as a bottom course. It also specifies a concrete base, with the aggregates so graded that the mortar in an approximate $1 : 2\frac{1}{2} : 5$ mix shall be not less than 110 per cent of the voids in the coarse aggregate. The coarse aggregate must be No. 34 size; limestone of grades A, B and C, trap rock, grade B slag, vitrified clay, or grade B gravel are permitted. Sand must have not over 5 per cent of clay or silt, which will not be permitted if it coats the grains. Not more than 30 per cent must pass a No. 50 sieve and not over 70 per cent be retained on a 20 sieve. A $1 : 3$ mortar must develop 85 per cent of the strength of mortar made with standard Ottawa sand. Materials may be mixed by hand or in a batch machine for 15 revolutions made in 45 to 60 seconds. No variation from the true surface by over $\frac{1}{4}$ inch is permitted, when tested with template and straight edge. Concrete may be laid in cold weather if special precautions are taken. Surface must be kept covered and damp 5 days and travel kept off 10 days. A water-bound foundation may also be used.

Illinois specifies a $1 : 3\frac{1}{2} : 6$ mix with graded aggregates and its equivalent with unscreened gravel. Sand must not contain over 3 per cent of clay and loam and not over 0.5 per cent humus or organic matter. In a $1 : 3$ mortar it must develop as much

strength as standard Ottawa sand. Gravel must be $\frac{1}{2}$ to 1 inch and broken stone $\frac{1}{2}$ to 1 inch. A batch mixer running at not over 22 revolutions per minute is required, and the minimum size is that taking a one-sack of cement batch. At least 10 revolutions must be given and more if the engineer orders them. The concrete must be kept wet for 4 days and no hauling on it or rolling or tamping of brick is permitted within 14 days. Deviations of more than $\frac{1}{4}$ inch from the true surface must be corrected.

Cushion.—In New York, the cushion must be $1\frac{1}{2}$ inches thick after rolling with a roller weighing 150 pounds per foot of width. The sand for the cushion must pass a No. 6 sieve and 90 per cent must pass a No. 20 sieve. An "excessively fine sand" is not desired, and if more than 10 per cent of loam and silt are present the sand "may" be rejected.

New Jersey requires a 1-inch cushion of sand consolidated with a small hand roller.

Maryland requires a cushion not exceeding $1\frac{1}{2}$ inches thick, of sand free from "all substances, except that it may contain, but not exceed, 20 per cent of loam." It must be consolidated with a 250 to 300-pound hand roller.

Ohio specifies a cushion not exceeding $1\frac{1}{2}$ inches thick of sand containing not more than 10 per cent of clay, loam or silt. This is compacted by a roller weighing not less than 10 pounds per inch of width and having a diameter of about 24 inches.

The Illinois cushion is a $\frac{3}{4}$ -inch bed of a 1 : 4 dry mixture of cement and sand, consolidated with a hand roller weighing 15 pounds per inch of width. All bed placed in excess of what can be covered with brick the same day must be removed from the concrete before the close of the day.

Brick laying.—The New York, Maryland, Ohio and Illinois specifications require practically the same method of laying, differing only in the detail with which certain features are described. The blocks must be set with the best edge up, laid straight and at right angles to the side lines. Each alternate course commences with a half brick. All joints must be broken with a lap of at least 3 inches in New York and Maryland. All blocks must be laid with the lugs in the same direction. After the blocks are laid the pavement must be rolled with a self-propelled tandem roller weighing 3 to 5 tons. The rolling begins at one curb and is continued practically longitudinally to the center, then it is begun at the other curb and carried on in the same way to the center, and finally the rolling is done diagonally on lines making an approximate right angle with each other. There seems to be a tendency toward detailed specifications for handling the brick, in order to prevent injury to them.

Longitudinal joints.—New York specifies either poured joints or premolded joints, the latter of a high-grade asphalt, which is required to have 99.5 to 99.9 per cent of bitumen soluble in carbon disulphide and a penetration of 40 to 50 at 77° F. The joints are required on each curb. In Maryland, a $\frac{1}{4}$ -inch joint is required next one curb on streets under 12 feet wide, and a joint next each curb on streets 12 feet or more wide, the thickness of the joint ranging from $\frac{1}{4}$ inch for 12-foot roadways to $1\frac{1}{4}$ inches for streets 30 feet or more wide. Either strip or poured joints are permitted, and either tar or asphalt may be used. Ohio requires premolded strips containing not less than 35 per cent of asphalt; they are placed where shown on the plans. Illinois specifies a $\frac{1}{4}$ -inch felt strip, impregnated with tar or asphalt, along one curb.

Joints.—Cement grout joints of the character recommended by the National Paving Brick Manufacturers Association are specified with little change in New York, Maryland, Ohio and Illinois. After the joints are poured traffic must be kept off the streets for 10 days in New York and Ohio, 14 days in Maryland and 21 days in Illinois. Ohio also specifies a bituminous filler.

Concrete Highways

The one-course concrete highway is constructed on practically the same specifications, those of the American Concrete Institute, in most States. The usual mix is about 1 : $1\frac{1}{2}$: 3, using a sand with not more than 3 to 5 per cent of the grains passing a 100-mesh screen, and a coarse aggregate from $1\frac{1}{2}$ inches down. There are some variations from these general limits as to size of aggregates, and in Illinois a 1 : 2 : $3\frac{1}{2}$ mix is specified. Massachusetts adds hydrated lime in an amount equal to 8 per cent of the cement. The time of mixing is usually specified as about 45 to 60 seconds or an equivalent number of revolutions of the mixer. The consistency of the finished mixture must be such that the concrete will hold its shape when struck off with a template and not result in a separation of the mortar from the coarse aggregate in handling.

Side forms are generally permitted to be metal or plank not less than 2 inches thick. Several States require the plank to be capped with a light metal angle iron to serve as an accurate guide for the template used in striking off the concrete. When the template is within 3 feet of a transverse joint, the specifications usually require it to be lifted to the joint, and the pavement struck by moving the template away from the joint. The surface is finished by floating, working from a bridge that does not touch the concrete, no variations exceeding $\frac{1}{4}$ inch from the true surface

being permitted. The surface is sprayed with water as soon as it has hardened enough to prevent pitting, and in some States, a shelter of canvas or tar paper must be supported over it for the first few hours. As soon as it is hard enough to permit spreading earth over it, this is done, the depth specified varying from 1 to 2 inches. This earth is then kept wet for periods ranging from 5 days in New Jersey to 14 in Massachusetts and Illinois. Traffic is kept off the surface for a period, measured from the finishing of the surface, of at least 10 days in New York, New Jersey and Maryland, 14 days in Massachusetts, 21 days in Ohio and 30 days in Illinois.

In Massachusetts, contraction joints of three layers of three-ply asphalt felt are located every 30 feet. The same distance is maintained in New York, but the type of joint is designated in the plans rather than the specifications. There is no standard spacing for joints in the New Jersey specifications, which permit a tar or oil paper joint, or one formed by filling a $\frac{1}{4}$ -inch transverse slot with an approved hot bituminous cement. In Maryland the joints are 60 feet apart on grades of 4 per cent or less, and 30 feet apart on grades over 4 per cent. They are $\frac{1}{4}$ inch wide and made of three-ply tar paper. In Ohio, the joint is made of tar paper, a premolded bituminous strip, a bituminous mastic, or metal, and the joint spacing is 30 feet. In Illinois, the joints are 33 $\frac{1}{2}$ feet apart and of an approved metal type.

Materials for Roads

Gravel.—New York specifies for road grave', clean, sound, tough, hard stone, separated into five sizes and meeting the specifications for broken stone except that gravel may contain not more than 5 per cent of loam, but must otherwise be free from dirt or foreign matter and must be washed when directed by the engineer.

New Jersey requires road gravel to be "composed of quartz pebbles, sand, clay and oxide of iron in such quantities that the gravel will be compacted into a hard, dense pavement." At least 95 per cent must pass a $1\frac{1}{4}$ -inch circular opening and at least 65 per cent must pass a $\frac{1}{2}$ -inch opening. Pebble gravel in which clay is the binder must have 25 to 35 per cent of a size retained on $\frac{1}{4}$ -inch circular openings, 40 to 60 per cent retained on a 10-mesh sieve, 8 to 20 per cent passing a 200-mesh sieve, remainder a fairly well graded, sharp sand. Sandy gravel depending upon oxide of iron for its cementing properties must have 20 to 40 per cent of a size retained on a 10-mesh sieve, and 10 to 25 per cent passing a 200-mesh sieve, 40 per cent of this fine material being soluble in 1 : 3 hydrochloric acid.

Ohio specifies three grades of gravel. Grade A must be thor-

oughly clean and free from sandstone, shale, slate, coal or other easily disintegrated material, vegetable matter, or soft, flat or elongated particles. When 5 kilograms and six cast-iron spheres 1.875 inches in diameter are given 10,000 revolutions at 30 to 35 revolutions per minute in a Deval apparatus the loss by abrasion must not exceed 12 per cent. Grade B must be well graded in size, hard, durable, without material which disintegrates or is of an otherwise deleterious nature, and without more than 2 per cent of clay or silt, which is not permitted at all if it coats the stone. Grade C is run-of-bank gravel passing a $3\frac{1}{2}$ -inch ring, with the material passing a $\frac{1}{4}$ -inch screen not more than 10 per cent in excess of the voids in the remaining material. The material passing the $\frac{1}{4}$ -inch screen must contain not less than 12 nor more than 20 per cent of silt or clay.

Illinois requires road gravel to be rather uniformly graded in size from fine material to anything passing a $3\frac{1}{2}$ -inch ring, with not over 15 per cent of pebbles (exclusive of clay) passing a $\frac{1}{4}$ -inch sieve. Not more than 5 per cent of loam is allowed but it should contain from 15 to 25 per cent of clay. Bonding gravel must be from 1 inch down in size, with at least 40 per cent of pebbles retained on a $\frac{1}{4}$ -inch screen, not more than 5 per cent loam and 15 to 25 per cent clay.

Illinois requirements for gravel for bituminous roads are that its coefficient of wear must equal that specified for stone and meets the following requirements for size. (a) Passing a 3-inch ring and uniformly graded to sand; 15 to 25 per cent, exclusive of clay, must pass a 1-inch ring. The maximum limit of bonding clay is 20 per cent. (b) This is termed 1-inch gravel; it must pass a 1-inch ring and be caught on a $\frac{3}{4}$ -inch circular opening; from 20 to 70 per cent must be held on a $\frac{3}{4}$ -inch screen and it must not contain over 2 per cent of clay, loam and other foreign matter. (c) Uniformly graded material passing a $1\frac{1}{2}$ -inch ring and caught on a $\frac{3}{4}$ -inch ring, with not over 2 per cent of loam and clay. (d) Passing a $\frac{3}{4}$ -inch ring and uniformly graded down to sand caught on a No. 20 sieve. (e) Passing a $\frac{3}{4}$ -inch circular opening and uniformly graded to fine sand. When absolutely clean and free from all foreign material it is called torpedo gravel. When 40 to 80 per cent will pass a No. 20 sieve and there is not over 2 per cent of loam and clay it is called grit sand.

Broken stone.—New York specifies clean, sharp angled stone passing the abrasion and toughness tests of the American Society for Testing Materials.¹ Rounded field stones must be at least 6

¹ American Society for Testing Materials Abrasion Test.—The machine shall consist of one or more hollow iron cylinders, closed at one end and furnished with a tightly-fitting iron cover at the other; the cylinders are to be 20 centimeters in diameter and 34 centimeters in depth, inside. These

inches in diameter, and flat stones at least 2 inches thick before crushing. The broken stone must be of uniform quality, and be screened to the following sizes:

New York Standard Sizes for Gravel and Broken Stones

NAME	SCREENINGS	NO. 1	NO. 2	NO. 3	NO. 4
Maximum, inches.....	$\frac{1}{2}$ square	$\frac{1}{2}$ square	$\frac{3}{4}$ circ.	$1\frac{1}{2}$ circ.	$2\frac{1}{2}$ circ.
Minimum, inches.....		$\frac{3}{4}$ circ.	$1\frac{1}{2}$ circ.	$2\frac{1}{2}$ circ.	$3\frac{1}{2}$ circ.

New Jersey specifications require broken stone to be as nearly cubical as possible. It must be trap or other approved native rock, free from all screenings, clay, soil or other objectionable substances. It is graded as follows:

Dust, not over 5 per cent retained on $\frac{1}{4}$ -inch circular openings; must be free from soil, loam and clay. When used for bituminous mortars, 55 to 70 per cent must be retained on a 30-mesh sieve, 15 to 30 per cent must pass an 80-mesh sieve, and 5 to 15 per cent pass a 200-mesh sieve.

cylinders are to be mounted on a shaft at an angle of 30 degrees with the axis of rotation of the shaft. At least 30 pounds of coarsely broken stone shall be available for a test. The rock to be tested shall be broken in pieces as nearly uniform in size as possible, and as nearly 50 pieces as possible shall constitute a test sample. The total weight of rock in a test shall be within 10 grams of 5 kilograms. All test pieces shall be washed and thoroughly dried before weighing. Ten thousand revolutions, at the rate of between 30 and 33 per minute, shall constitute a test. Only the percentage of material worn off which will pass through a 0.16-centimeter mesh sieve shall be considered in determining the amount of wear. This may be expressed either as the percentage of the 5 kilograms used in the test, or the French coefficient, which is in more general use, may be given; that is, coefficient of wear = $400/w$, where w is the weight in grams of the detritus under 0.16 centimeter in size per kilogram of rock used. (This is also known as the Deval test.)

American Society for Testing Materials Toughness Test.—Test pieces may be either cylinders or cubes, 25 millimeters in diameter and 25 millimeters high, cut perpendicular to the cleavage of the rock. Cylinders are recommended as they are cheaper and more easily made. The testing machine shall consist of an anvil of 50-kilograms weight and placed on a concrete foundation. The hammer shall be of 2 kilograms weight and dropped upon an intervening plunger of 1 kilogram weight, which rests on the test piece. The lower or bearing surface of this plunger shall be of spherical shape having a radius of 1 centimeter. This plunger shall be made of hardened steel and pressed firmly upon the test piece by suitable springs. The test piece shall be adjusted so that the center of its upper surface is tangent to the spherical end of the plunger. The test shall consist of a 1 centimeter fall of the hammer for the first blow and an increased fall of 1 centimeter for each succeeding blow until failure of the test piece occurs. The number of blows necessary to destroy the test piece is used to represent the toughness, or the centimeter-grams of energy applied may be used. (This is also known as the Page test).

Three-eighths-inch stone must not have over 5 per cent of material retained on $\frac{1}{2}$ -inch circular openings or over 4 per cent passing $\frac{1}{4}$ -inch circular openings.

Dustless screenings contain not over 5 per cent of material retained on $\frac{1}{4}$ -inch circular openings or 8 per cent passing $\frac{1}{4}$ -inch circular openings.

Screenings are the run-of-crusher product in which not over 5 per cent remains on $\frac{1}{4}$ -inch circular openings.

Three-quarter-inch stone contains not over 5 per cent of material retained on $1\frac{1}{2}$ -inch circular openings nor over 8 per cent passing $\frac{1}{4}$ -inch circular openings.

Interlocking $1\frac{1}{2}$ -inch stone is retained on a $1\frac{1}{2}$ -inch ring and passes a $2\frac{1}{2}$ -inch ring.

One-and-one-half-inch stone passes a $2\frac{1}{2}$ -inch ring and is retained on a $1\frac{1}{2}$ -inch ring.

Two-and-one-half-inch stone passes a $3\frac{1}{2}$ -inch ring in any direction and is retained on a $2\frac{1}{2}$ -inch ring.

Ohio specifications provide for using various grades of several materials. Limestone is specified in three grades, as follows:

	GRADE A	GRADE B	GRADE C
	per cent	per cent	per cent
Calcium carbonate, minimum.....	65	60	55
Abrasion loss, maximum.....	6	10	12
Hardness factor, minimum.....	14	12	10
Toughness, minimum.....	5	5	4

In the case of dolomitic limestone, the sum of the calcium and magnesium carbonates must be at least 70, 65 and 60 per cent in grades A, B and C respectively. The abrasion and toughness tests are the same as those of the American Society for Testing Materials; the hardness test is the Dorry hardness test explained in the notes on page 209. Trap rock must show not over 5 per cent abrasion, a factor of hardness of at least 17 and a factor of toughness of at least 8. Sandstone must show not over 25 per cent abrasion, and a toughness of at least 3.

The Ohio standard sizes for mineral material are:

No. 1 must pass a 4-inch circular opening and be retained on a $2\frac{1}{2}$ -inch opening, except No. 1 size for stone with an abrasion loss of less than 6 per cent is material passing a $3\frac{1}{2}$ -inch opening and retained on one of 2 inches.

No. 2 must pass a $2\frac{1}{2}$ -inch circular opening and be held on one of $1\frac{1}{2}$ inches.

No. 3 must pass a $1\frac{1}{2}$ -inch circular opening and be held on one of $\frac{1}{4}$ -inch.

No. 4, grit, must pass a $\frac{3}{4}$ -inch opening and be held on one of $\frac{1}{2}$ inch.

No. 5, screenings, must pass a $\frac{3}{4}$ -inch opening and from 40 to 80 per cent must be held on a $\frac{1}{4}$ -inch circular opening or square mesh.

No. 6, grit, must pass a $\frac{1}{2}$ -inch opening and be held on a $\frac{1}{8}$ -inch opening or mesh.

No. 7, screenings, must pass a $\frac{1}{2}$ -inch opening or mesh and not over 30 per cent should pass a No. 100 sieve.

No. 23 must pass a $2\frac{1}{2}$ -inch opening and be held on one of $\frac{3}{4}$ -inch.

All the above sizes must be so graded that in a laboratory test not over 10 per cent will pass the minimum opening.

No. 34 must pass a $1\frac{1}{2}$ -inch opening, and contain not more than 5 per cent which will pass a $\frac{1}{4}$ -inch opening, and not more than 75 per cent "that will pass or be retained on a $\frac{3}{4}$ -inch opening."

Massachusetts bituminous macadam specifications call for two sizes of broken stone. No. 1 will pass a $2\frac{1}{2}$ -inch ring and be held on a $1\frac{1}{2}$ -inch ring. No. 2 will pass a $1\frac{1}{2}$ inch ring and be held on a $\frac{1}{2}$ -inch ring.

Illinois specifications require a coefficient of wear by the Deval test of not less than 8 when the material is used for the second course and not less than 6 for the bottom course. If its cementing value is less than 20, a good bonding gravel must be used with it. These standard sizes are provided: 3-inch, passing a 3-inch ring and caught on a 1-inch ring; $2\frac{1}{2}$ -inch passing a $2\frac{1}{4}$ -inch ring and caught on a 1-inch ring; screenings, passing a $\frac{3}{4}$ -inch circular opening and caught on a $\frac{1}{4}$ -inch opening; $1\frac{1}{2}$ -inch, passing a $1\frac{1}{4}$ -inch ring and caught on a $\frac{3}{4}$ -inch ring, with 30 to 80 per cent caught on a 1-inch ring.

Slag.—New York specifies acid slag, clean, sound, tough, hard, sharp-angled, weighing at least 1800 pounds per cubic yard, and conforming to the requirements for broken stone.

New Jersey specifications reject slag that is brittle, glassy, of a specific gravity exceeding 3.0 at 15.5°C., or weighing less than 2400 pounds per cubic yard.

Two grades of slag are specified in Ohio. Grade A must have 32 per cent of silica, not over 45 per cent calcium oxide and not over $1\frac{1}{2}$ per cent of sulphur. Its abrasion loss must not exceed 10 per cent, its minimum hardness must be 16 and its toughness at least 5. It must weigh at least 75 pounds per cubic foot, and when tested in a Deval machine in the usual manner, but with a charge of only 5 kilograms and six cast-iron 0.95-pound spheres, the loss must not exceed 20 per cent. Grade B slag must contain not less than 30 per cent of silica, not over 45 per cent of calcium oxide, and not over 1.5 per cent of sulphur. The abrasion loss must not exceed 12 per cent, the hardness factor must be 14 or more and the toughness 5 or more.

Illinois specifications permit the use of slag "subject to the approval of the engineer."

Vitrified clay.—Ohio specifications call for vitrified clay crushed and screened like rock. It must be clean, sound, sharp-angled, of uniform quality and free from thin flat pieces. After 48 hours in water, it must show an absorption of not over $3\frac{1}{2}$ per cent. The abrasion loss must not exceed 10 per cent, and the toughness must be at least 5.

Asphalt.—The tests conducted in New York, Ohio and Illinois are practically the same, and enable the requirements for the material for both penetration and mixing methods to be compared readily.

Specific gravity at 97° F. is 0.97 for all these materials in New York and Ohio, but in Illinois it is 1.00 for grade A and 0.97 to 1.00 for grade B.

Solubility in carbon disulphide is 99.5 per cent for pure bitumen products in each State, 96 per cent in New York and 95 per cent in Ohio and Illinois for Bermudez products, 81 per cent in New York and Ohio and 80 per cent in Illinois for Cuban products, and 66 per cent in New York and Ohio and 65 per cent in Illinois for Trinidad products.

The penetration in millimeters during 5 seconds at 77° F. with a No. 2 needle loaded with 100 grams is as follows:

New York; type 1, mixing method, 8 to 12; type 2, mixing method, 6 to 8; penetration method, 14 to 19.

Ohio; penetration method, 9 to 12 for pure bitumen products and 12 to 16 for fluxed native asphalt; type 1, mixing method, 7 to 9 for pure bitumen products and 9 to 12 for fluxed native asphalts; type 2, mixing method, 6 to 8.

Illinois; grade A permitted for both mixing and penetration methods, 8 to 12 for products having over 90 per cent total bitumen; 7 to 10 for products containing 80 to 90 per cent total bitumen; 5 to 8 for Trinidad products containing less than 80 per cent of total bitumen. Grade B, permissible for both mixing and penetration methods; 5 to 8.

Loss on evaporation at 325° F. in 5 hours.—New York, types 1 and 2 for mixing method 4 per cent; for penetration method, 5. Ohio, all types, 5. Illinois, grade A, 6; grade B, 2. The penetration of the residue must be 50 per cent of that of the original material for all classes in the three States except Illinois grade B, which must be 40 per cent.

Solubility in 86° B. paraffine naphtha.—New York, types 1 and 2 for mixing method, 68 to 88 per cent; penetration method, 70 to 88. Ohio, penetration method and type 1 mixing method, 72 to 85; type 2 mixing method, 70 to 85; Illinois, grade A, 72 to 85; grade B, 72 to 80.

Fixed carbon.—New York and Ohio, types 1 and 2 for mixing method, 8 to 17 per cent; penetration method, 8 to 16. Illinois, grade A, 8 to 16; grade B, 7 to 14.

Flash point in open cup.—New York, 375° F. Ohio, 356° F. Illinois, grade A, 325° F.; grade B, 392° F.

Ductility at 77° F., Dow mould.—New York, types 1 and 2, mixing method, 25 centimeters; penetration method, 40. Ohio, penetration method and type 1 mixing method, 30; type 2 mixing method, 25. Illinois, grade A, 50; grade B, 15.

New York also limits the paraffine scale to 4.7 per cent and requires the Page toughness test, as follows: mixing method, 10 centimeters for type 1 and 5 centimeters for type 2; penetration method, 15.

Ohio specifies that not over 1 per cent of the total bitumen in any type shall be insoluble in carbon tetrachloride. Illinois specifies a limit of 0.5 per cent for grade B.

Illinois specifies that a cylinder of either grade A or grade B, 1 centimeter in diameter, after being maintained at 41° F. for 20 minutes, shall bend 180 degrees at any point without checking or breaking.

The requirements for asphalts for other road purposes in the different States are too divergent to be summarized here to advantage.

Tar.—The requirements of the different States for tar for penetration and mixing methods are based on tests which are not, as a rule, sufficiently uniform to justify comparison except by specialists. For the classes of work covered by this digest, some of the requirements of New York and Ohio are as follows:

	NEW YORK		OHIO	
	1.2 min. 12-25	1.16 min. 5 max.	1.20-1.27 10-22	1.16-1.20 10 max.
Specific gravity, 77° F.				
Free carbon, per cent.				
Distillates				
below 338° F.....	0	0	0	0
below 456° F.....	3	5		
below 518° F.....	12	15	10	10
below 572° F.....	16	20	20	20
specific gravity.....	1.03 min.		1.03 min.	1.00 min.

In both States, the maximum melting point of the residue from distillation is 167° F.

In New York, the melting point of both tars is limited between 80° and 93° F.

In Ohio, the consistency as determined by the New York Testing Laboratory float test at 122° F. is 2 to 3 minutes for high carbon tar and 2½ to 3½ minutes for low carbon tar.

The Illinois specifications give a minimum specific gravity of 1.22 and 22 per cent maximum free carbon. The distillate below 230° F. must not exceed 2 per cent and must be free from ammoniacal water; below 338°, it must not exceed 5 per cent; at 555°, it must be at least 15 per cent. The consistency by the float test must be 2 to 3 minutes. A cylinder of tar 1 centimeter in diameter, kept at 32° F. for 20 minutes, must bend into a semicircle of 3 centimeters diameter without checking or binding.

The requirements for tars for other road purposes in the different States are too divergent to be summarized here to advantage.

Brick.—New York, Ohio and Illinois specifies $3\frac{1}{2} \times 4 \times 8\frac{1}{2}$ inches as standard size, with a permissible variation of $\frac{1}{8}$ inch in depth and width and $\frac{1}{2}$ inch in length. New Jersey specifies $3\frac{1}{2}$ to $3\frac{3}{4}$ inches width, $3\frac{1}{4}$ to $4\frac{1}{4}$ inches depth and $8\frac{1}{4}$ to $9\frac{1}{4}$ inches length. Maryland specifies 3 to $3\frac{1}{2}$ inches width, 4 to $4\frac{1}{2}$ inches depth and $8\frac{1}{2}$ to 9 inches length.

The rattler test of the American Society for Testing Materials is specified in New York, New Jersey, Maryland, Ohio and Illinois. New York and Ohio also require an absorption test and New York and New Jersey specify a modulus of rupture. The specific requirements of the rattler test varies in the different States, in order to meet their local conditions.

TABLES OF QUANTITIES, WEIGHTS AND MEASUREMENTS FOR USE IN ROAD WORK

Crushed Stone Required per Mile of Macadam Road

WIDTH, FEET	THICKNESS COMPACTED, INCHES	TONS OF STONE REQUIRED
8	4	875
	6	1,312.50
	8	1,750
	10	2,187.50
	12	2,625
9	4	984.37
	6	1,476.56
	8	1,968.75
	10	2,460.94
	12	2,953.12
10	4	1,093.75
	6	1,640.62
	8	2,187.50
	10	2,734.37
	12	3,281.25
12	4	1,312.50
	6	1,968.75
	8	2,625
	10	3,281.25
	12	3,937.50
14	4	1,531.25
	6	2,296.87
	8	3,062.50
	10	3,828.12
	12	4,593.75
15	4	1,640.62
	6	2,460.94
	8	3,281.25
	10	4,101.56
	12	4,921.87
16	4	1,750
	6	2,625
	8	3,500
	10	4,375
	12	5,250

Number of Square Yards in One Mile of Road

WIDTH, FEET	SQUARE YARDS
8	4,693.33
10	5,866.66
12	7,040
14	8,213.33
16	9,386.66
18	10,560

Cubic Yards of Gravel for Constructing One Mile of Road

WIDTH, FEET	THICKNESS COMPACTED, INCHES	CUBIC YARDS GRAVEL, COMPACTED	CUBIC YARDS GRAVEL, LOOSE
8	6	782.22	1173.33
	7	912.59	1368.88
	8	1142.93	1564.39
	9	1173.33	1760.00
	10	1303.70	1955.55
9	6	890.00	1320.00
	7	1026.67	1540.00
	8	1173.33	1760.00
	9	1320.00	1980.00
	10	1466.66	2200.00
10	6	977.77	1466.65
	7	1140.74	1711.11
	8	1303.70	1955.55
	9	1466.67	2200.00
	10	1629.63	2444.44
12	6	1173.33	1760.00
	7	1368.88	2053.32
	8	1564.44	1846.66
	9	1760.00	2640.00
	10	1955.55	2933.32
14	6	1368.88	2053.32
	7	1597.04	2595.56
	8	1825.19	2737.78
	9	2053.33	3079.99
	10	2281.44	3422.16
15	6	1466.67	2200.00
	7	1711.11	2566.66
	8	1955.55	2933.32
	9	2200.00	3300.00
	10	2444.44	3666.66
16	6	1564.44	2346.66
	7	1825.19	2737.78
	8	2085.93	3128.89
	9	2346.67	3520.00
	10	2607.41	3911.11

TRANSPARENT
TRACKLESS

NON-ASPHALTIC

THE DUSTOLINE CO. FOR ROADS

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We furnish Crushed Slag and Crushed Stone
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GOOD CONCRETE—and that means concrete made with high quality Portland Cement and aggregates—grows stronger with age, until it becomes practically as imperishable as cut stone.

You cannot have cement or aggregates that are too good when the road or driveway is to stand the severest tests of traffic and weather.

ALPHA CEMENT is as good a Portland Cement as can be made. It represents 25 years of experience in cement-making.

ALPHA is tested hourly by chemists who are men of real authority in all ALPHA plants.

You can always be sure that every bag of ALPHA is correctly proportioned, thoroughly burned and finely ground—that it will more than meet all standard requirements.

A little difference is a big difference in a product like cement.

The six great ALPHA plants are on six trunk-line railroads, and one plant is, with its private docks, directly on the Hudson River; capacity 25,000 barrels daily; storage for 2,000,000 barrels.

ALPHA PORTLAND CEMENT CO.

GENERAL OFFICES: EASTON, PA.

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Pittsburgh, Baltimore, Savannah

USE ALPHA CEMENT THE GUARANTEED
PORTLAND CEMENT



Four-foot Apollo Culvert which replaced a ten-foot wooden bridge in roadway near Alpena, Michigan.

APOLLO

KEYSTONE COPPER STEEL

Galvanized Sheets

Recognized highest quality and most rust-resistant galvanized sheets now manufactured. Unequaled

For Roadway

Culverts

Flumes, Tanks and all forms of exposed sheet metal work. Irrespective of the design of Culvert you select, demand that the material used be Apollo-Keystone Copper Steel Galvanized Sheets, thereby insuring the maximum of service and satisfaction. Note the following remarkable growth:

1911	-	-	-	5,311 TONS
1913	-	-	-	74,495 TONS
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1915	-	-	-	150,000 TONS +

Write for booklet, "Keystone Copper Steel—a Discussion on Corrosion."

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Low in magnesia and sulphuric anhydride
Densest and most waterproof concrete



ASH GROVE Superfine Portland Cement

Guaranteed 10 per cent Finer on
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Specifications Require

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Refined tar products for
use in the constuction and
preservation of road surfaces

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Concrete for Good Roads

Build in concrete (1) for *durability*—concrete is unaffected by traffic, alternate freezing and thawing, or heat or cold; (2) for *low first cost*—concrete is the least expensive of all permanent roads; (3) because you want *low maintenance*—concrete up-keep is lowest, an average of \$25 per year per mile. And a concrete road ensures easy traction, is mudless and dustless.



Genesee Street, Morrison, Ill.
Constructed of Atlas Portland Cement

Atlas Road-building Service

Our road engineers are fully prepared to co-operate with you. We will assist in preparing plans and estimates and will submit approximate cost and maintenance data, if you will tell us the cost of sand, gravel and unskilled labor in your locality. We will also arrange for inspection, if desirable.

The Atlas Book on Highway Construction tells costs and contains illustrations of typical roads and streets. It is free on request; together with Standard Specifications.

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The Standard by which all other makes are measured

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TO BUILD

CONCRETE ROADS



When it passes over the concrete it not only leaves a perfect crown but forces out all bubbles of air and excess water.

The vibrating and compressing pan tamps the concrete, producing a smooth hard wearing surface. Its use increases the life of a road one-third.

Specify MACHINE FINISHED, and get the best surface possible.

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THE BAKER STEEL CURB FORM

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Write for “BAKER WAY” Catalog

THE R. D. BAKER COMPANY, Detroit, Mich.

The Standard of Comparison for Paving and Road Materials

To claim that a paving or road-building material is as good as Trinidad or Bermudez asphalt is considered the strongest endorsement that can be brought forward.

But the materials for which this claim is made are usually new and untried, and year after year one "Just-as-good-as-lake-asphalt" follows another into oblivion.

**Trinidad
Liquid
Asphalt**

**Bermudez
Road
Asphalt**

**Trinidad
Lake
Asphalt**

Meanwhile the use of the lake asphalts steadily increases, and their position as the standard materials by which all others are judged is more firmly fixed (1) by the continued good service of natural asphalt roads and pavements, some of which, though 30 years old, are in service today; and (2) by the duplication of unfortunate experience with artificial or manufactured asphalt.

Engineers and officials with reputations to preserve, and taxpayers whose money is to be spent may well consider also that even if there was any material for paving and road-building equaling the lake asphalts in stability, dependability and long life, it would take 30 years to prove it.

**THE BARBER ASPHALT PAVING
COMPANY**

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Guaranteed 99.84% pure iron



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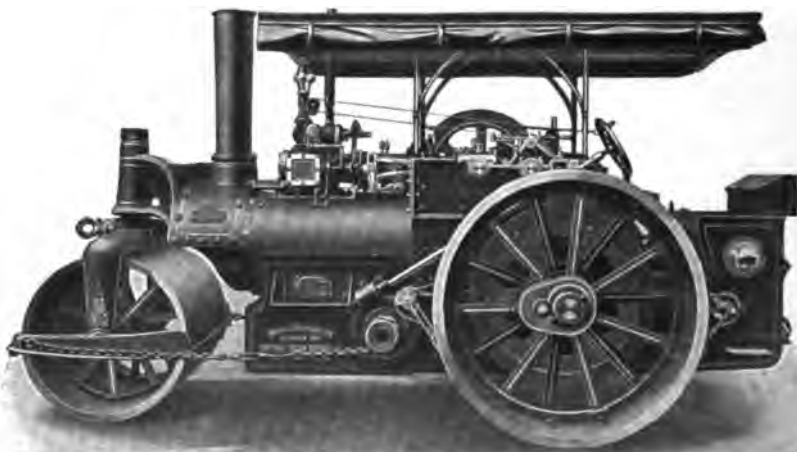
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Their record for efficiency and durability is unequalled

Made in all types and all sizes for all purposes 2½ to 20 tons

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Road Materials, Etc.

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Barrett materials combine knowledge and experience.

"Tarvia-X" is used as a binder in the construction of macadam roads.

"Tarvia-A" and **"Tarvia-B"** are used for maintenance on many kinds of roads.

Barrett's Paving Pitch is used as a filler on stone block, wood block and brick paving. Special grades are made to meet every requirement and a new mastic filler has been developed for use in stone and brick pavements.

Barrett's Expansion Joint, made by the Fibre-Weld process is the best expansion joint for concrete, brick and all cement grouted pavements and sidewalks.

Barrett's Grade One Creosote Oil is designed for preserving all timber used in highway fences and bridges.

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Build a Road Like This

This is a picture of Beech Grove Road out of Indianapolis, Ind. It is a one-course concrete road 18 ft. wide. The cost was not much more than the cost of macadam, and the maintenance on

this excellent concrete road will be a matter of small cost. Its hard surface will be appreciated every day in the year. In the construction of the Beech Grove Road, CHICAGO-AA Portland Cement was used. CHICAGO-AA always satisfies.

Ask us for free booklets on Concrete Roads.

CHICAGO PORTLAND CEMENT CO.,

30 N. La Salle St.
CHICAGO

Concrete for Permanence

1915 was a good year for concrete roads, and 1916 promises to be still better. During the past year, concrete was established in a number of sections where it had been previously unknown for straight concrete road construction, and 1916 will find the same thing occurring in other sections, and once the concrete road "gets there" it stays, for everything is in its favor.

Many thousands of barrels more of "GIANT" Portland Cement were shipped during the past twelve months for use in this class of road construction, and "GIANT" continues to sustain our claim that it is as well adapted for concrete road work as for any of the other multitudinous uses to which it has been put.

If you figure on doing concrete pavement work, just start with "GIANT" Portland Cement in your calculations, and if your selection of the other materials is as discriminating, you are bound to finish a good job.

Giant Portland Cement Company

1883-1916

WORKS

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Concrete for Permanence



"CRESCENT" for Concrete

There is Nothing Mysterious About Concrete Roads

Every Taxpayer Can Easily Understand the Simple Principles of Good Construction



CONCRETE is very different from macadam. The great difference lies in the fact that a concrete road is a solid durable slab of stone; the macadam road a closely packed mass of crushed stone rolled down to a smooth surface. The concrete road is cemented into a single mass; sand, gravel and stone and cement have been permanently united. The macadam road is held together usually by a binder, and when the binder melts or is sucked out by passing wheels the road rapidly crumbles. The concrete road has no binder to be destroyed; it cannot be disintegrated. The heaviest traffic cannot cut its flinty surface; the suction of automobile tires cannot harm it. A concrete road never softens in the sun; it becomes stronger every year.

The cost of a concrete road varies with the locality and the cheapness of labor and materials, but an estimate of \$12,000 per mile for a 16-foot road is approximately the average; a cost of only a little greater than that of macadam.

Upkeep, that ever-increasing burden with other types of roads, amounts to practically nothing for the concrete road. A range of \$25 to \$75 a year per mile should amply provide for the most careful inspection and repair.

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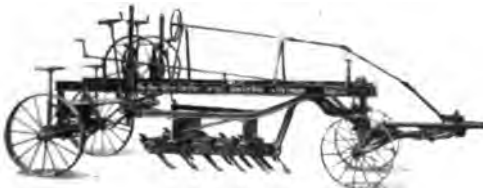
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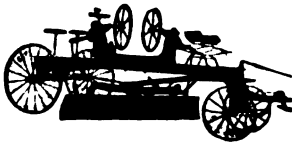
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(Read article on Asphalt Blocks, Page 223)

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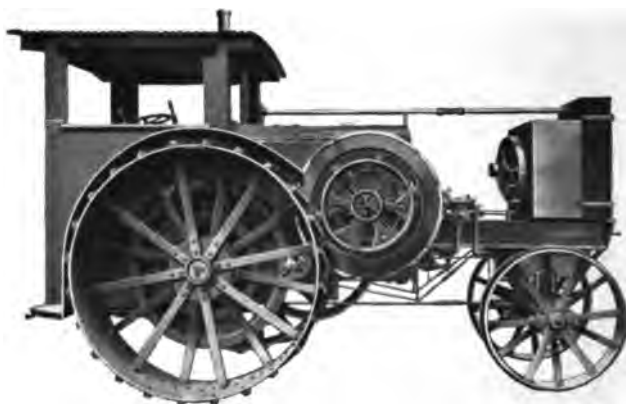
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HOW much more money would you make for yourself or for your community if you found a way to cut 25 per cent off the present cost of grading roads? If you are still using horse or mule power, we can show you a way to save even more than that. If you are using a gasoline tractor, we can still show you how to make a profitable saving.

Every dollar you cut the cost of road grading is a dollar added to your net profit. We can put you in touch with one man who says he cut the cost of road grading in Louisiana from **\$26 per mile** with mule power to **\$4.50 per mile** with **Mogul** kerosene tractor power. His figures are in the official records of his parish.

That is probably an extreme case, but the fact that so large a saving as this could be made, is interesting. It suggests that possibly your costs are higher than they need be. Perhaps a little investigation would pay. Would you like to see some of the figures we have collected—some of the savings we have helped other contractors and road builders to make by changing over to **Mogul** or **Titan** kerosene tractor power? They'll cost you nothing but a two-cent stamp and a little time. Write for them.

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Complete Testing Equipment for Road
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Why continue repairing your wornout macadam roads, which is a constant and continued expense, and, after years of repairing, all you have to show for this great maintenance expense are the same wornout roads, when WARRENITE can be had at a reasonable cost?



The following extract from editorial—North Bend, Ore., Harbor of October 21, 1915, is interesting:

"The editor of this paper has driven a car thousands of miles over California's best roads, but never have we had the pleasure of driving over a road that equalled the Columbia River Highway, which the Warren Construction Company has just about completed. The road is not only a scenic boulevard, but is built to stand for all time. We believe that for workmanship, quality of material, finish and general appearance no road in Oregon or California equals it."

The above road referred to is WARRENITE.

WARRENITE is the best surfacing for macadam roads.

"The man who never makes a mistake never learns anything."

But there is no need of making the same mistake twice. If you have in the past constructed roads that will not withstand the modern automobile traffic and which have to be practically rebuilt each year at a great expense, don't repeat the experience but surface them with WARRENITE—it's cheaper to do it now than later.

WARRENITE is laid under the same general principle and with the same care and laboratory supervision which has made the Bitulithic Pavement so popular.

Now is the time for you to consider what roads you are to resurface this spring.

Investigate WARRENITE before making your decision.

Other counties are contracting for WARRENITE. WHY DON'T YOU?
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Don't Fight Today's Battles With Yesterday's Weapons

The most successful contractors have either supplanted their old-fashioned horses and wagons with motor trucks or are gradually doing so.

Read what James A. Mullen of Philadelphia, says of his Garford:

"I have been using one of the large Garfords as well as several other makes of motor vehicle. I find it almost indispensable.

"I have considerable long distance hauling and in instances of this kind *it supplants five and six double teams.*

"I have about 200 horses in daily use, but this truck appeals very strongly to me and I

feel that the Garford will soon usurp the horse method of transportation."

"*Supplants five or six double teams*"—think of the saving—not only in cost of vehicles but in the wages of drivers as well.

You can operate a Garford Motor Truck just as successfully in *your* business.

Our complete line of styles and sizes enables us to offer a Garford to fit exactly the requirements of any business.

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A few months ago S. M. Williams, sales manager of the Garford Motor Truck Company, distributed several thousand copies of his booklet, "Roads—Their Influence Upon Economic and Social Conditions," among state and county officials, engineers, prominent business men and educators. Since then requests have been received from Good Roads Associations, Chambers of Commerce, and influential business men for over 200,000 copies of this booklet for distribution in good roads campaigns in all sections of the country. Your copy will be mailed free upon request.

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PART III
Miscellaneous

HIGHWAY BONDS

On January 1, 1914, there had been voted by 1,230 counties, 41.1 per cent. of all in the country, highway and bridge bonds to the amount of \$286,557,073. Of this amount township bonds alone amounted to \$57,153,718. The States had voted \$158,590,000 highway bonds, making the total bonded indebtedness incurred for highway and bridge purposes \$445,147,073. This enormous indebtedness is analyzed in detail in Bulletin 136 of the U. S. Department of Agriculture, by Dr. Laurence I. Hewes, chief of economics and maintenance of the U. S. Office of Public Roads and Rural Engineering, and Prof. James A. Glover, of the University of Michigan. The frequency with which bonds are being voted and their importance as investments as well as means of providing funds for road improvements have led to the reproduction in the following pages, by permission of Logan Waller Page, director of the Office of Public Roads and Rural Engineering, of the important explanation by Messrs. Hewes and Glover of the nature of different classes of bonds and the valuable bond tables prepared by them. There is so much discussion of the subject at the present time by many who evidently do not understand the mathematical accuracy with which the value of different types of bonds can be weighed, that the information is as timely as it is permanently valuable.

Up to the present time the majority of bonds have been all terminable at a stated time, ranging from 10 to 50 years and averaging nearly 25 years, and have been retired by sinking funds accumulated by annual payments. The sums in the sinking fund are assumed to draw interest. In practice the amount of this interest fluctuates, there is a constant temptation to use the sinking fund for other purposes than that for which it is accumulated, and cases have arisen when the sums for the annual payments have not even been levied.

Annuity bonds are those in which both the principal and interest are discharged by constant annual or semi-annual payments. The amount of principal retired in the early years is small and increases steadily as the amount of annual interest decreases as a result of the decrease in the outstanding bonded indebtedness.

Serial bonds are those in which a fixed amount of principal is retired annually. It has become a favored type in some sections of the country.

The total expense to a community of bonds issued under the serial plan is somewhat less than under the annuity plan, and both serial and annuity bonds cost less to a community than do bonds issued under the sinking fund plan. From the point of view of the investor, however, the desirability of bonds issued under the three plans is the reverse of that stated, for he desires to obtain the maximum return on his investment. The condition of the bond market represents at any time an equilibrium between the supply of bonds and the market for them, and the character of a bond issue managed by an experienced financier will be governed in a considerable degree by the character of the market anticipated at the time the bonds will be sold.

THEORY OF INTEREST APPLIED TO BOND CALCULATIONS

(Appendix D, Bulletin 136, U. S. Department of Agriculture; reprinted by permission)

Introduction.—This appendix presents briefly the application of the theory of compound interest to highway bonds. There are six important quantities in terms of which the solution of most problems can be expressed. If i is the rate of interest and n the term of years, these quantities are:

The accumulation of 1 at the end of n years, s^n ;

The accumulation of an annuity of 1 per annum at the end of n years, $s_{\overline{n}|}$;

The annual sinking fund which will accumulate to 1 at the end of n years, $1/s_{\overline{n}|}$;

The present value of 1 due in n years, v^n ;

The present value of an annuity of 1 per annum for n years, $a_{\overline{n}|}$; and

The annuity for n years which 1 will purchase, or the annuity necessary to discharge a debt of 1 in n years with interest, $1/a_{\overline{n}|}$.

The first three are accumulative functions and the last three are discount or present value functions.

The mathematical formulas for these six quantities are:

$$\begin{array}{lll} s^n = (1+i)^n & s_{\overline{n}|} = \frac{(1+i)^n - 1}{i} & \frac{1}{s_{\overline{n}|}} = \frac{i}{(1+i)^n - 1} \\ v^n = (1+i)^{-n} & a_{\overline{n}|} = \frac{1 - (1+i)^{-n}}{i} & \frac{1}{a_{\overline{n}|}} = \frac{i}{1 - (1+i)^{-n}} \end{array}$$

The values of most of these functions are given more or less completely in published tables of interest.¹

Definitions.—*Interest* may be defined as the consideration for the use of capital. The capital is called the *principal*.

The *rate* at which a given principal is earning interest requires the adoption of some interval as the unit of time, and this is usually the *year*.

It is clear that interest when received may be added to the principal and so in turn earn interest. This process, called *compounding*, takes place at the end of *stated intervals*, as every three months, six months, or year.

¹ At the end of this appendix, pages 322 to 345 are short tables to seven places for 60 intervals and 14 interest rates.

Mathematical rates.—The *effective rate of interest* is the interest earned by one unit of principal (one dollar) in one unit of time (one year) when interest is *compounded* at the end of each *stated interval*.

The *nominal rate of interest* is the total interest earned by one unit of principal (one dollar) in one unit of time (one year) when interest is *not compounded* at the end of each *stated interval*.

It follows that the nominal and effective rates of interest coincide only when the *stated interval* is the unit of time (one year).

Commercial rate.—In commercial transactions the rate of interest is usually quoted as a rate *per cent*, or per hundred units of principal, instead of a rate *per unit* of principal, as in the above definitions. To find the mathematical rate as above defined, divide the commercial rate by 100. For example, the mathematical rate corresponding to the commercial rate 6 per cent is $6/100$, or .06. The mathematical rate is used in the following formulas.

Relation between effective and nominal rates of interest.—In any transaction there is an effective rate of interest i and a corresponding nominal rate of interest j . This relation can be expressed by an algebraic formula which involves the number of *stated intervals*, m , in one year. At the nominal rate j , during each stated interval $1/m$ th of a year in length, one unit of principal would earn j/m in interest which, added to the unit, gives an amount $1 + j/m$. If the principal 1 accumulates in the first interval to $1 + j/m$, it follows by proportion that the principal $1 + j/m$ would accumulate in the second interval to $(1 + j/m)^2$. In like manner, at the end of the m th interval, the accumulation would be $(1 + j/m)^m$. The total interest earned in the m intervals, or one year, is the difference between the accumulation and the original unit of principal, which by definition is the *effective rate* of interest i . Hence the fundamental formula:

$$i = (1 + j/m)^m - 1 \quad (1)$$

or

$$1 + i = (1 + j/m)^m, \quad (2)$$

Solving for j , there results

$$j = m[(1 + i)^{1/m} - 1]. \quad (3)$$

The number of times, m , that interest is added, or converted into principal each year, is the *frequency of conversion*. A nominal rate of interest, convertible m times a year, is indicated by the symbol $j_{(m)}$.

Example 1.—The nominal rate of interest j on deposits is 3% and interest is added to the principal every six months; to find the effective rate i .

Here $j = .03$ and $m = 2$. From formula (1) there results

$$i = (1 + .03/2)^2 - 1 = (1.015)^2 - 1 = .030225.$$

The effective rate 3.0225% is thus slightly higher than the corresponding nominal rate convertible twice per annum.

Example 2.—The effective rate of interest is 6%; to find the corresponding nominal rate when interest is convertible semiannually.

Here i and m are given to find j ; hence from formula (3) there results

$$j = 2[(1+.06)^{\frac{1}{2}} - 1] = 2(1.03 - 1) = 2.059126 - 2 = .059126.$$

It is necessary to extract the square root of 1.06. The final result shows that $j = 5.9126\%$, and again the nominal rate is smaller than the corresponding effective rate.

Amount of 1 in n years at compound interest.—Let the effective rate of interest be i . At the end of the first year the accumulation is $1+i$. During the second year this principal $1+i$ will be increased in the ratio of 1 to $1+i$, and will therefore amount at the end of the second year to $(1+i)(1+i)$, or $(1+i)^2$. In this way at the end of n years the amount is $(1+i)^n$.

Let P be the principal and S the amount of P at the end of n years at compound interest at the effective rate i . Since 1 amounts to $(1+i)^n$ in n years, P would amount to $P(1+i)^n$. There results, therefore, the formula

$$S = P(1+i)^n. \quad (4)$$

Hence

$$P = S/(1+i)^n = Sv^n, \quad (5)$$

where

$$v = 1/(1+i). \quad (6)$$

If in the above formulas $1+i$ is replaced by $(1+j/m)^m$, to which it is equivalent according to formula (2), it follows that

$$S = P(1+j/m)^{mn}, \quad (7)$$

and

$$\text{where } P = S/(1+j/m)^{mn} = Sv^{mn}, \quad (8)$$

$$v = 1/(1+j/m). \quad (9)$$

These formulas express the relation between P and S in terms of the nominal rate j and the frequency of conversion m . The values to seven places of decimals of $(1+i)^n$ and v^n for various rates of interest and for 60 intervals or years are given in Tables 31 and 34.

Example 3.—To find the amount of \$12,375 at 3% compound interest in 30 years. By formula (4)

$$S = (1+.03)^{60} \times \$12,375 = 2.4272625 \times \$12,375 = \$30,037.37.$$

The value of $(1.03)^{60}$ was taken from Table 31.

Example 4.—\$12,375 is placed in a bank; to find the amount in 30 years if interest is 3% and is compounded semiannually.

The nominal rate of 3%, convertible twice a year, requires formula (7) with $j=.03$ and $m=2$. Substituting, the result is:

$$S = (1+.03/2)^{120} \times \$12,375 = (1.015)^{120} \times \$12,375 = 2.4432198 \times \$12,375 = \$30,234.85.$$

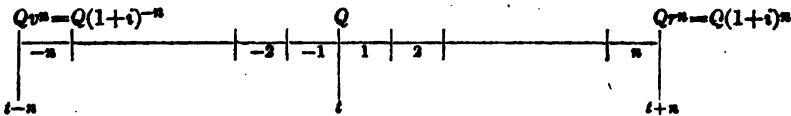
The discount factor.—Because of the power of money to earn interest the value of money depends upon the time to which it is referred. Then in order to compare sums of money due at different times, they must be referred to the *same point in time*.

Formula (5) gives the principal P which will accumulate at the effective rate i in n years to the amount S . If $S=1$ and $n=1$, the formula gives the present value of 1 due in one year. This is usually denoted by the symbol v , so that

$$v = 1/(1+i) = (1+i)^{-1}.$$

Similarly $v^2 = 1/(1+i)^2 = (1+i)^{-2}$ is the present value of 1 due in two years, and $v^n = 1/(1+i)^n = (1+i)^{-n}$ is the present value of 1 due in n years.

The symbol v is often called the discount factor, and if it is desired to find the value of money n years *before the point in time under consideration*, it is necessary only to multiply the quantity by v^n . The factor $1+i$, which is frequently denoted by r , is accumulative in character, and formula (4) shows that, to find the value of a quantity of money Q , n years *after the point in time under consideration*, it is necessary merely to multiply the quantity by $(1+i)^n$.



More generally, when i is the effective rate per interval, the value of Q , at a time n intervals after the point t , is $Q(1+i)^n = Qr^n$, and its value n intervals before point t is $Q(1+i)^{-n} = Qv^n$.

Annuities-certain.—An *annuity* is a series of payments made at *equal intervals* during the continuance of a given *status*.

The *status*, or condition of payment of the annuity, may take a variety of forms. If the status is a fixed term of years, the annuity is an *annuity-certain*. Thus payments of one hundred dollars a year for ten years constitute an annuity-certain. The sum of the payments on an annuity in one year, when the payments are of the same amount, is the *annual rent*.

Payments of twenty-five dollars are made at the end of every month for ten years. This is an annuity-certain with an annual rent of three hundred dollars.

When payments are made at the *end* of each interval, the annuity-certain is said to be *immediate*; when payments are made at the *beginning* of each interval, the annuity-certain is said to be *due*.

Amount of an immediate annuity-certain.—The value of an annuity at the end of its term is called the *amount*. The amount of an immediate annuity-certain for n years with an annual rent 1,

payable at the end of each year, is designated by the symbol s_n . To find s_n each annual payment must be accumulated, at the effective rate of interest i , to the end of the term of the annuity. The first payment of 1 accumulates in $n-1$ years to $(1+i)^{n-1}$; the second payment of 1, in $n-2$ years, to $(1+i)^{n-2}$; etc.; the $(n-1)$ th payment of 1, in 1 year, to $(1+i)$; and the n th payment at the end of the term is 1. Adding the separate amounts in reverse order, there results

$$s_n = 1 + (1+i) + (1+i)^2 + \dots + (1+i)^{n-1}.$$

The sum of this geometric series is

$$s_n = \frac{(1+i)^n - 1}{i}. \quad (10)$$

Values of this quantity are given for various rates of interest and terms in Table 32.

Example 5.—To find the accumulation in 47 years of an annual sinking fund of 1% of \$1,000,000, if the fund is credited annually with 3% compound interest.

This is an application of formula (10) where $n=47$ and $i=.03$; since $s_{47}=100.3965009$ the accumulation will be

$$100.3965009 \times \$10,000 = \$1,003,965.01.$$

The same principles may be applied to find the amount of an annuity for n years with annual rent 1 payable in p equal installments during each year. The amount of such an annuity is designated by the symbol $s_n^{(p)}$, and its value is represented by the following formula:

$$s_n^{(p)} = \frac{(1+i)^n - 1}{p[(1+i)^{1/p} - 1]}. \quad (11)$$

If $1+i$ is replaced by $(1+j/m)^m$ in accordance with formula (2), the amount of the annuity is then expressed in terms of the nominal rate of interest j with frequency of conversion m , thus:

$$s_n = \frac{(1+j/m)^{mn} - 1}{(1+j/m)^m - 1}, \quad (12)$$

$$s_n^{(p)} = \frac{(1+j/m)^{mn} - 1}{p[(1+j/m)^{m/p} - 1]}. \quad (13)$$

Example 6.—What will be the accumulation in 47 years of an annual sinking fund of 1% of \$1,000,000, paid in semiannually, if the fund is credited as received with 3% interest compounded annually?

This is an application of formula (11) where $n=47$, $p=2$, $i=.03$, hence

$$s_{47}^{(2)} = \frac{(1+.03)^{47} - 1}{2[(1+.03)^{1/2} - 1]} = \frac{3.0118950}{.0297783} = 101.143954$$

and the accumulation will be $101.143954 \times \$10,000 = \$1,011,439.54$.

The special case where interest is converted with the same frequency as the payment of annuity installments, or when $m=p$, deserves particular mention. Formula (13) then reduces to

$$s_{\overline{n}|p}^{(p)} = \frac{1}{p} \cdot \frac{(1+j/p)^{np} - 1}{j/p} = \frac{1}{p} \cdot s_{\overline{np}|} \quad (14)$$

where $s_{\overline{np}|}$ is to be taken at the effective rate j/p .

Example 7.—What will be the accumulation in 47 years of an annual sinking fund of 1% of \$1,000,000, paid in semiannually, if the fund is credited with a nominal rate of 3% convertible twice a year?

This is an application of formula (14) where $n=47$, $p=2$, and $s_{\overline{n}|p}$ is taken at $1\frac{1}{2}\%$; hence

$$\frac{1}{2}s_{\overline{94}|} \times \$1,000,000 = \$1,017,764.25.^1$$

Sinking fund which will amount to 1.—An annuity with annual rent of 1 will amount in n years to $s_{\overline{n}|}$; it follows that an annuity with annual rent of $1/s_{\overline{n}|}$ will amount in n years to 1. The quantity $1/s_{\overline{n}|}$ is the *sinking fund* which will accumulate to 1 in n years.

Values for this important function

$$\frac{1}{s_{\overline{n}|}} = \frac{i}{(1+i)^n - 1} \quad (15)$$

are given for various rates of interest and for terms ranging from 1 to 60 intervals or years in Table 33.

Example 8.—To find an annual sinking fund, which, credited with 3% compound interest, will accumulate in 50 years to \$1,000,000.

Applying formula (15) where $n=50$, and $i=.03$, there results $1/s_{\overline{50}|} = .0088655$. Therefore the required sinking fund is

$$.0088655 \times \$1,000,000 = \$8,865.50.$$

In like manner $1/s_{\overline{n}|}^{(p)}$ is the annual rent of an annuity which, at the nominal rate j convertible m times a year, will accumulate to 1 in n years. The annual rent is payable in p installments during each year; hence each installment is equal to $1/(ps_{\overline{n}|}^{(p)})$. The installments may be regarded as the sinking fund, payable at the end of every p th part of a year, which in n years will accumulate to 1. The amount of each payment to the sinking fund is

$$\frac{1}{ps_{\overline{n}|}^{(p)}} = \frac{(1+j/m)^{m/p} - 1}{(1+j/m)^{mn} - 1} \quad (16)$$

When $p=1$ and $m=2$, formula (16) gives the value of the *annual* sinking fund which, improved at compound interest *semiannually*, will accumulate in n years to 1.

The formula simplifies to the following:

$$\frac{(1+j/2)^2 - 1}{j/2} \cdot \frac{j/2}{(1+j/2)^{2n} - 1} = s_{\overline{2}|} \cdot \frac{1}{s_{\overline{2n}|}} \quad \text{at rate } j/2. \quad (17)$$

This formula is of considerable practical importance because payments to the sinking fund are usually made annually and the fund

¹ For calculation of $s_{\overline{n}|}$ see Example 22, page 329

credited with interest semi-annually. The table on page 91 of the 1915 Year Book was calculated by formula (17).

Example 9.—To find the annual payment which will accumulate in 20 years to \$100,000 when interest is $3\frac{1}{2}$ per cent compounded semiannually.

Taking $n=20$ and $j=.035$ and consulting Tables 32 and 33 with $1\frac{1}{2}$ per cent interest for values of $s_{\overline{n}|j}$ and $1/s_{\overline{n}|j}$, respectively, there results:

$$s_{\overline{n}|j} \cdot \frac{1}{s_{\overline{n}|j}} = 2.0175 \times .0174721 = .0352500.$$

Hence the annual payment to sinking fund is

$$.0352500 \times \$100,000 = \$3,525.00.$$

Example 10.—To find the sinking fund, which set aside semiannually and accumulated as received, with 3% compound interest, will amount in 50 years to \$1,000,000.

Here formula (16) is used with $p=2$, $m=1$, $j=.03$, $n=50$, and

$$\frac{1}{2s_{\overline{n}|j}} = \frac{(1+.03)^{\frac{1}{2}} - 1}{(1+.03)^{50} - 1} = .00439999.$$

The required sinking fund is therefore

$$.00439999 \times \$1,000,000 = \$4,399.99.$$

In the special case when the frequency of conversion coincides with the number of payments per annum, or $m=p$, the amount of each payment to the sinking fund is

$$\frac{1}{ps_{\overline{n}|j}} = \frac{j/p}{(1+j/p)^n - 1} = \frac{1}{s_{\overline{n}|p}}, \quad (18)$$

where $s_{\overline{n}|p}$ is to be taken at rate j/p .

Example 11.—To find a sinking fund which, set aside semiannually and credited with a nominal rate of 3% convertible twice a year, will accumulate in 30 years to \$1,000,000.

Here apply formula (18) by substituting $p=2$, $j=.03$, and $n=30$; this gives

$$\frac{1}{2s_{\overline{n}|j}} = \frac{1}{s_{\overline{n}|p}} = .0103934,$$

where $1/s_{\overline{n}|p}$ is taken at $1\frac{1}{2}\%$. Then the sinking fund which would accumulate to \$1,000,000 is

$$.0103934 \times \$1,000,000 = \$10,393.40.$$

Four important cases of sinking funds are illustrated in the preceding examples. They arise from the fact that payments to a sinking fund may be annual or semiannual and interest on a sinking fund annual or semiannual. Formula (16) covers all of them when p and m are properly chosen. The following schedule illustrates this fact:

Case.	p	Sinking-fund payments.	m	Interest on sinking fund.	Illustrated in example.
1	1	Annual	1	Annual	8
2	1	Annual	2	Semiannual	9
3	2	Semiannual	1	Annual	10
4	2	Semiannual	2	Semiannual	11

In most cases in the illustrative tables in the body of Bulletin 136 for simplicity of presentation, annual payments and annual interest are assumed, whereas in practice usually annual payments and semi-annual interest are employed.

Present value of an immediate annuity-certain.—The present value of an immediate annuity-certain for n years, with annual rent 1 payable at the end of each year, is designated by the symbol $a_{\overline{n}|}$.

It is equal to the sum of the present values of 1, due at the succeeding yearly intervals. By formula (5) the present value of 1, due at the end of one year at the effective rate of interest i , is $v = 1/(1+i)$; at the end of two years, $v^2 = 1/(1+i)^2$, etc.; at the end of n years, $v^n = 1/(1+i)^n$. Hence

$$\begin{aligned} a_{\overline{n}|} &= v + v^2 + \dots + v^n \\ &= \frac{1}{1+i} + \frac{1}{(1+i)^2} + \dots + \frac{1}{(1+i)^n}. \end{aligned}$$

The sum of this geometric series is

$$a_{\overline{n}|} = \frac{1-v^n}{i} = \frac{1-(1+i)^{-n}}{i} \quad (19)$$

and its values are given in Table 35.

Example 12.—To find the present value at 3% of an annual payment of \$56,325 at the end of each year for thirty years.

Referring to Table 35, it is seen that $a_{\overline{30}|}$ at 3% is 19.6004413, and therefore the required present value is

$$19.6004413 \times \$56,325 = \$1,103,994.86.$$

While the above demonstration relates to an annuity of 1 per annum, payable at the end of each year, the same principles apply to finding the present value of an annuity of 1 per annum, payable in p installments during each year. The present value of such an annuity is designated by the symbol $a_{\overline{n}|}^{(p)}$, and its value is represented by the following formula:

$$a_{\overline{n}|}^{(p)} = \frac{1-v^n}{p[(1+i)^{1/p} - 1]} = \frac{1-(1+i)^{-n}}{p[(1+i)^{1/p} - 1]}. \quad (20)$$

In formulas (19) and (20) the values of the annuities are expressed in terms of the effective rate i . If $(1+i)$ is replaced by $(1+j/m)^m$ in accordance with formula (2), there result the present values of the same annuities expressed as follows in terms of the nominal rate of interest j , with frequency of conversion m :

$$a_{\overline{n}|} = \frac{1-(1+j/m)^{-mn}}{(1+j/m)^m - 1}, \quad (21)$$

and

$$a_{\overline{n}|}^{(p)} = \frac{1-(1+j/m)^{-mn}}{p[(1+j/m)^{m/p} - 1]}. \quad (22)$$

Fundamental relations between the present value and the amount of an annuity.—Since $a_{\overline{n}|}$ and $s_{\overline{n}|}$ are the values of the same annuity upon two dates differing by n years, it follows by the principle of reduction of values from one date to another, explained on page 311 that

$$a_{\overline{n}|} = v^n s_{\overline{n}|},$$

$$s_{\overline{n}|} = (1+i)^n a_{\overline{n}|},$$

and in like manner that

$$a_{\overline{n}|}^{(p)} = v^n s_{\overline{n}|}^{(p)},$$

$$s_{\overline{n}|}^{(p)} = (1+i)^n a_{\overline{n}|}^{(p)}.$$

As tables are not published giving the values of $a_{\overline{n}|}^{(p)}$ and $s_{\overline{n}|}^{(p)}$, when p is different from 1, it is desirable for purposes of computation to express a relation between these functions and the tabulated functions $a_{\overline{n}|}$ and $s_{\overline{n}|}$. This can easily be done by accumulating to the end of each year the p payments of $1/p$ which in $a_{\overline{n}|}^{(p)}$ and $s_{\overline{n}|}^{(p)}$ are distributed at equal intervals through the year. By formula (11) this accumulation to the end of each year will be equal to

$$s_{\overline{1}|}^{(p)} = \frac{i}{p[(1+i)^{1/p} - 1]} = \frac{i}{j(p)}.$$

This converts the annuity into one with annual rent $s_{\overline{1}|}^{(p)}$ payable at the end of each year for n years. Therefore

$$a_{\overline{n}|}^{(p)} = s_{\overline{1}|}^{(p)} a_{\overline{n}|}, \quad (23)$$

$$s_{\overline{n}|}^{(p)} = s_{\overline{1}|}^{(p)} s_{\overline{n}|}. \quad (24)$$

The most frequent intervals in practice are semiannual, quarterly, and monthly, and to meet this requirement the values of $s_{\overline{1}|}^{(2)}$, $s_{\overline{1}|}^{(4)}$, and $s_{\overline{1}|}^{(12)}$ are given below for various rates of interest.

Values of $s_{\overline{1} }^{(p)} = \frac{i}{j(p)} = \frac{i}{p[(1+i)^{1/p} - 1]}$							
p	1½%	1¾%	2%	2½%	2½%	3%	3%
2	1.00872604	1.00435608	1.00497535	1.00559371	1.00621143	1.00682937	1.00744459
4	1.00590755	1.00553878	1.00746906	1.00899639	1.00932677	1.01025632	1.01118072
12	1.00695652	1.00799671	1.00913389	1.01027107	1.01140725	1.01254263	1.01367662
p	3½%	4%	4½%	5%	5½%	6%	7%
2	1.00867475	1.00990195	1.01112621	1.01234754	1.01356596	1.01478151	1.01720402
4	1.01308094	1.01457744	1.01672026	1.01850943	1.02059495	1.02222665	1.02589002
12	1.01594293	1.01820351	1.02046109	1.02271479	1.02496465	1.02721070	1.03169143

Example 18.—What is the present value of an annuity for 30 years at effective rate 3%, payable in monthly installments of \$25?

By formula (23) with $n=30$, $p=12$, $i=.03$,

$$a_{\overline{30}|}^{(12)} = s_{\overline{1}|}^{(12)} \cdot a_{\overline{30}|} = 1.01367662 \times 19.6004413 = 19.86850909.$$

Therefore the present value of a similar annuity of \$25 per month, or with annual rent of \$300, is

$$19.86850909 \times \$300 = \$5,960.55.$$

The annuity which 1 will purchase.—The present value $a_{\overline{n}|i}$ of an annuity may be viewed as the principal which, invested at the effective rate of interest i , will provide a payment of 1 at the end of each year and will not be exhausted until the end of the n th year; in other words, $a_{\overline{n}|i}$ is just sufficient to purchase an n year annuity of annual rent 1 payable at the end of each year. By proportion it appears that 1 will purchase an n year annuity of annual rent $1/a_{\overline{n}|i}$ payable at the end of each year. This quantity may be described as the annuity which 1 will purchase, and its value is

$$\frac{1}{a_{\overline{n}|i}} = \frac{i}{1-v^n} = \frac{i}{1-(1+i)^{-n}}. \quad (25)$$

This function is of great importance in annuity bond calculations, and its values are given for 60 terms and different rates of interest in Table 36, on pages 342 and 343.

Example 14.—To find the uniform annual payment which in 20 years will discharge a loan of \$100,000, including both principal and interest, at 5 per cent compounded annually.

In this case $n=20$, $i=.05$; employing formula (25) and referring to Table 36, it follows that a loan of 1 will be discharged, both principal and interest, by an annual payment of

$$\frac{1}{a_{\overline{20}|.05}} = .0802426;$$

hence the loan of \$100,000 will be likewise discharged by an annual payment of

$$.0802426 \times \$100,000 = \$8,024.26.$$

By similar reasoning it follows that 1 will purchase an immediate annuity-certain with annual rent $1/a_{\overline{n}|i}^{(p)}$, payable in p installments each year. The value of each *periodical installment* is

$$\frac{1}{pa_{\overline{n}|i}^{(p)}} = \frac{(1+j/m)^{n/p} - 1}{1 - (1+j/m)^{-n}}, \quad (26)$$

where interest is at the nominal rate j with frequency of conversion m . When $m=1$, the nominal rate $j_{(1)}$ becomes the effective rate i . When the conversion of interest occurs with the same frequency as the periodical payment, that is, when $m=p$, formula (26) reduces to the important particular case

$$\frac{1}{pa_{\overline{n}|i}^{(p)}} = \frac{j/p}{1 - (1+j/p)^{-n}} = \frac{1}{a_{\overline{n}|j/p}}, \quad (27)$$

where $a_{\overline{n}|j/p}$ is to be taken at rate j/p .

Example 15.—To find the half yearly payment at 5% compounded semiannually which will discharge both principal and interest on a loan of \$100,000 in three years.

By formula (27) with $n=3$, $p=2$, a loan of 1 will be discharged, both principal and interest, in three years by a semiannual payment of

$$\frac{1}{a_{\overline{6}|.025}} \text{ (taken at } 2\frac{1}{2}\% \text{)} = .1815500,$$

and the loan of \$100,000 will be discharged in like manner by

$$.1815500 \times \$100,000 = \$18,155.00.$$

Installment annuity loan.—The preceding example shows how the function $1/a_{\overline{n}|i}$ may be employed to determine the periodical fixed payment which in n years will discharge both principal and interest on a loan. It is to be noted particularly that the lender receives interest throughout the term of the loan on all *outstanding* principal. The following schedule, based on the above example, illustrates the progress of the loan.

SCHEDULE I.—*Showing repayment of principal and interest on a loan of \$100,000 by six equal semiannual payments, each of \$18,155; interest 5 per cent, compounded semi-annually.*

Year.	Principal outstanding at beginning of interval.	Interest for interval.	Semiannual payment.	Principal repayment for interval.
$\frac{1}{2}$	\$100,000.00	\$2,500.00	\$18,155.00	\$15,655.00
1	84,345.00	2,108.63	18,155.00	16,046.37
$1\frac{1}{2}$	68,298.63	1,707.47	18,155.00	16,447.53
2	51,851.10	1,296.28	18,155.00	16,858.72
$2\frac{1}{2}$	34,992.38	874.81	18,155.00	17,280.19
3	17,712.19	442.81	18,155.00	17,712.19
Totals	357,199.30	8,930.00	108,930.00	100,000.00

The initial invested principal of \$100,000 earns \$2,500 interest during the first half year; the first payment of \$18,155.00 takes care of this and there remains a balance of \$15,655.00 which goes to reduce the outstanding principal to \$84,345.00, beginning with the second half year. This process is repeated until the end of the third year, when the last outstanding principal is retired. When preparing such a schedule, the work can be checked by adding the columns. It is evident from the nature of the calculations that, for example, if the first row were omitted from this schedule, the remaining five would represent the schedule for a loan of \$84,345.00 on the same terms as the original loan, except that it would be discharged in two and one-half years by five equal semiannual payments. It must therefore be the present value of the five payments, that is,

$$a_{\overline{5}|i} \times \frac{\$100,000}{a_{\overline{1}|i}} = \$84,345.00,$$

where the annuities are taken at $2\frac{1}{2}$ per cent. Similarly, by successively employing $a_{\overline{4}|i}$, $a_{\overline{3}|i}$, $a_{\overline{2}|i}$, and $a_{\overline{1}|i}$, all at $2\frac{1}{2}$ per cent, as multipliers, the figures in the first column of principal outstanding at the beginning of the interval could be obtained. When these are known, the figures in the second column are obtained by multiplying the corresponding figures in the first column by the interest rate for the interval, .025; in the fourth, by successive subtractions of the figures

in the first; and in the third, by adding those in the second to those in the fourth as a check.

Generalization of the annuity loan.—The preceding discussion can most easily be generalized by considering the loan of a_n dollars where both principal and interest at *effective rate i per annum* are discharged by equal annual installments of 1 at the end of each year for n years. The initial principal is a_n ; the interest, $ia_n = 1 - v^n$; the annual payment, 1, of which $1 - (1 - v^n) = v^n$ is applied to repayment of principal. But $a_n - v^n = a_{n-1}$; hence the outstanding principal at the beginning of the second year is a_{n-1} , as might have been predicted in advance. A repetition of this process leads to the following schedule:

SCHEDULE II.—*Showing repayment of principal and interest at effective rate i per annum on a loan of a_n by equal annual payments of 1 at the end of each year for n years.*

Year.	Principal outstanding at beginning of year.	Interest due at end of year.	Annual payment at end of year.	Principal repaid at end of year.
1	a_n	$1 - v^n$	1	v^n
2	a_{n-1}	$1 - v^{n-1}$	1	v^{n-1}
3	a_{n-2}	$1 - v^{n-2}$	1	v^{n-2}
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
k	a_{n-k+1}	$1 - v^{n-k+1}$	1	v^{n-k+1}
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
n	a_1	$1 - v$	1	v
Totals	$(n - a_n)/i$	$n - a_n$	n	a_n

Since this is a schedule for a loan of a_n , if each item in it, apart from those in the column headed "year," is divided by a_n and multiplied by L , there results the corresponding schedule for a loan of L dollars.

For example, the items on a loan of L dollars for the k th year would be

$$La_{n-k+1}/a_n, \quad L(1 - v^{n-k+1})/a_n, \quad L/a_n, \quad Lv^{n-k+1}/a_n. \quad (28)$$

There are some curious properties revealed by the above schedule, among which the following may be pointed out. The principal repayments on an annuity loan increase in geometrical progression, the factor being $1 + i$. The sum of these repayments is a_n ; the sum of the annual payments is n ; the total interest is $n - a_n$; and the check on the first and second columns shows that

$$i(a_n + a_{n-1} + \dots + a_1) = n - a_n.$$

It is apparent that most of the items in the schedule can be filled in directly from the a_n and v^n tables. Having thus filled in each

number, it would be necessary only to multiply each item by L/a^n to obtain the corresponding schedule for a loan of L .

If in the preceding discussion *year* is replaced by *interval*, the schedule may be made to apply to loans repaid by equal installments at the end of each interval.

Relation between annuity which 1 will purchase and sinking fund which will amount to 1.—The important relation

$$\frac{1}{a_n} = \frac{1}{s_n} + i \quad (29)$$

can easily be verified by substitution of the values of $1/a^n$ and $1/s^n$ expressed in terms of i , by formulas (25) and (15).

The relation (29) merely expresses the fact that the annual rent, $1/a^n$ on the annuity which 1 will purchase, must include, not only the interest i on the unit so invested, but also a sinking fund, $1/s^n$, which will accumulate to the invested unit at the end of the term of the annuity.

Application to bond calculations.—An important application of the theory of compound interest and annuities arises in the valuation of bonds. First to determine the value of a bond issue redeemable in one sum on a given date, with interest, or dividends, on the outstanding bonds at rate g , and all computed, or *valued*, so as to yield the purchaser a given effective rate of interest i . Consider an issue of \$100,000 highway bonds, denomination \$500, dated January 1, 1914, maturing January 1, 1948, interest 5 per cent, payable annually.

The annual interest, or dividends, on these bonds is 5 per cent, and the bonds are redeemed at the end of 34 years. Suppose an intending purchaser desires to pay a price which will yield a net income of 3 per cent on his investment; how much ought he to bid? This is the nature of the general problem. If the purchaser desires to realize 5 per cent on his investment, he must bid \$100,000 for the bonds, or \$1 for each dollar to be redeemed. If, however, he is content with 3 per cent, more than \$100,000 must be paid for the bonds, that is, more than \$1 for each dollar to be redeemed. In this case the bonds are said to be bought at a *premium*; if less than \$1 is paid for each dollar to be redeemed, the bonds are said to be bought at a *discount*.

In the general case, let C denote the price to be paid on redemption; i , the effective rate of interest employed in the valuation of the bonds, which is the *net income* rate to the purchaser; g , the *ratio* of the dividend per annum to C ; n , the number of years after which the bonds are redeemed; K , the present value of C , due n years hence,

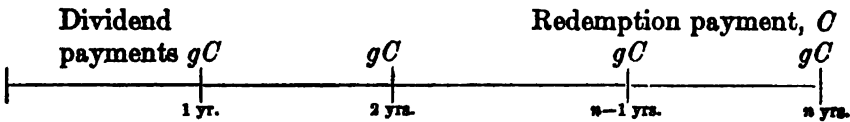
at the effective rate of interest i ; and A , the present value of, or bid on, the bonds.

In the above illustration $C=100,000$, and $n=34$. The dividend or interest per annum is 5,000. Hence $g=5,000/100,000=.05$.

Returning to the general problem, the value of the bonds, so far as the purchaser or holder is concerned, consists of two parts:

1. *The annual interest, or dividend, to be received.*
2. *The sum to be redeemed at the end of n years.*

Hence, to find the present value, A , of the bonds, the present value of each of these parts must be determined and added together. The interest per unit of the redemption price C is, by definition, g ; if the interest on 1 unit is g , the interest on C units is gC . Hence at the end of every year for n years the holder will receive gC units.



It is evident that these interest or dividend payments of gC at the end of every year constitute an immediate annuity-certain of annual rent gC and term of n years. The value of such an annuity with annual rent 1 is $a_{\overline{n}|}$; hence the value of the annuity with annual rent gC is

$$gC a_{\overline{n}|},$$

where $a_{\overline{n}|}$ is to be taken at the rate of interest i to be employed in the valuation of the bonds, a rate which in general is different from g , the rate of dividend.

By formula (5), the present value of the sum C , to be redeemed in n years, is $v^n C$.

Adding these parts together, the result is

$$A = v^n C + gC a_{\overline{n}|}.$$

Substituting in this relation the value of $a_{\overline{n}|}$ given by formula (19), it follows that

$$A = v^n C + \frac{g}{i}(C - v^n C).$$

Since, by definition, $K = v^n C$, the bid is given by

$$A = K + \frac{g}{i}(C - K) \quad (30)$$

and the premium by

$$A - C = (C - K) \frac{(g - i)}{i} \quad (31)$$

If in formula (31) the *total sum to be redeemed is regarded as unity*, then $C=1$ and $K=v^n$, the present value of 1 due in n years, and there results

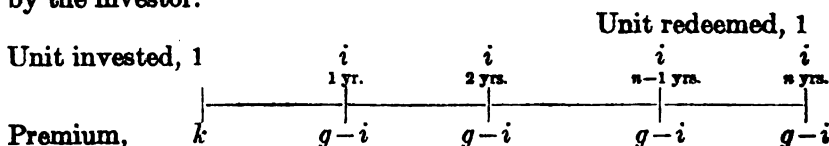
$$A = 1 + \frac{(1-v^n)}{i}(g-i) = 1 + (g-i)a_{\overline{n}|i}. \quad (32)$$

In this formula $a_{\overline{n}|i}$ is taken at i per cent, and gives the bid on a bond where the sum to be redeemed is 1. Denoting the excess of A over 1 by k , which is called the *premium*, formula (32) becomes

$$k = (g-i)a_{\overline{n}|i}^{\text{9\%}}, \quad (33)$$

where the i per cent over the symbol $a_{\overline{n}|i}$ means that the function is to be taken from the i per cent annuity table.

This is the fundamental formula in bond calculations. It admits of a very simple interpretation, for it states that the premium on a bond is equal to the present value of an n year annuity at i per cent whose annual rent is the excess $(g-i)$ of the nominal rate of dividend of the bond over the effective rate of interest i , desired to be realized by the investor.



The dividend paid each year on each unit of the bond to be redeemed is g , which may be divided into two parts, i and $g-i$. For the first part the investor pays 1 and in return receives interest of i each year and the 1 is redeemed at the end of n years. For the second part the investor pays the premium, $k = (g-i)a_{\overline{n}|i}$, and this is repaid, both principal and interest at rate i , in n equal annual installments of $(g-i)$. A portion of each installment goes toward the repayment of the premium k which is eventually reduced to zero. This is called the *amortization* or *writing off of the premium*.

It is thus seen that, if k is positive, the bond is bought at a premium; and if k is negative, it is bought at a discount. Since $a_{\overline{n}|i}$ is always positive, it appears from formula (33) that the sign of k will be positive when g is greater than i , or *when the rate of dividend is greater than the rate of interest used in valuation*; conversely, when g is less than i , k is negative.

Example 16.—To find the bid on the highway bond mentioned on page 104, on the hypothesis that the purchaser wishes to realize 3% on his investment.

Consider a dollar (unit) of the loan $C=100,000$. Here $n=34$, $g=.05$, $i=.03$, and by formula (33),

$$k = (.05 - .03)a_{\overline{34}|3\%} = .02 \times 21.1318367 = .422636734,$$

or the premium is slightly over 42 cents on the dollar. Since for each dollar of the loan the purchaser must pay \$1.422636734, for the whole loan of \$100,000 he must pay

$$1.422636734 \times \$100,000 = \$142,263.67.$$

Dividends payable and interest convertible semiannually.—When the net income interest rate desired by the investor is nominal, say $j_{(m)}$, and the dividends per unit of the sum to be redeemed are paid in m equal installments, g/m , during the year, it is evident that it is a case of m times n intervals with g/m as dividend and j/m as the *effective rate of interest per interval*. Hence formula (33) becomes

$$k = \frac{(g-j)}{m} a_{\frac{j/m\%}{m}}^{\frac{j/m\%}{m}}. \quad (34)$$

In particular, if the net income is $j_{(2)}$, and the dividend payments are semiannual,

$$k = \frac{(g-j)}{2} a_{\frac{j/2\%}{2}}^{\frac{j/2\%}{2}}. \quad (35)$$

This formula provides for the valuation of all bonds, redeemed in one sum at the end of a term of n years and with semiannual dividends. Particular attention is called to the fact that the annuity must be taken for the term $2n$, and at the rate of interest $j/2$.

Example 17.—What is the bid on \$100,000 highway 5% bonds maturing at the end of 3 years, interest payable semiannually, to net purchaser a nominal rate of 4% convertible half-yearly?

Here $n=3$, $g=.05$, $j=.04$, $m=2$, and formula (35) gives

$$k = \frac{(.05-.04)}{2} a_{\frac{2\%}{2}}^{2\%} = .005 \times 5.6014309 = .0280071545.$$

Hence the premium on \$100,000 is \$2,800.72, and the corresponding bid is \$102,800.72. The progress of this bond loan is illustrated in the following schedule.

SCHEDULE III.

Year.	Book value or principal at beginning of half-year.	Semiannual interest of 2%.	Semiannual dividend of 2% on bonds.	Amortization of premium at end of half-year.	Redemption payment at end of half-year.
$\frac{1}{2}$	\$102,800.72	\$2,056.01	\$2,500.00	\$443.99	0.00
1	102,356.73	2,047.13	2,500.00	452.87	0.00
$1\frac{1}{2}$	101,903.86	2,038.08	2,500.00	461.92	0.00
2	101,441.94	2,028.84	2,500.00	471.16	0.00
$2\frac{1}{2}$	100,970.78	2,019.42	2,500.00	480.58	0.00
3	100,490.20	2,009.80	2,500.00	490.20	\$100,000.00
Totals	609,964.23	12,199.28	15,000.00	2,800.72	100,000.00

At the outset the holder has an investment of \$102,800.72 upon which, at 2 per cent, at the end of the first half-year, \$2,056.01 interest is due; the dividend payment of \$2,500.00 then made on the bonds provides for this interest and a balance of \$443.99 remains, which is applied to *amortize* or *write off* the premium so that the *book-value*, or invested principal, is reduced to \$102,356.73 at the beginning of the second half-year. This process continues for three years until the entire premium of \$2,800.72 is written off and the bonds are redeemed by the payment of \$100,000. The various columns are added and the checks upon these totals are obvious.

Example 18.—What is the bid on \$100,000 highway 3% bonds maturing at the end of 3 years, interest payable semiannually, to net purchaser a nominal rate of 4% convertible half-yearly?

Here $n=3$, $g=.03$, $j=.04$, $m=2$, and formula (35) gives

$$k = \frac{(.03 - .04)}{2} a_{\overline{6}|i}^{2\%} = -.005 \times 5.6014309 = -.0280071545.$$

Hence the *discount* on \$100,000 is \$2,800.72, and the corresponding bid is \$97,199.28. The progress of this bond loan is illustrated in the following schedule.

SCHEDULE IV.

Year.	Book value or principal at beginning of half-year.	Semiannual interest of 2%.	Semiannual dividend of 1% on bonds.	Accumulation of discount at end of half-year.	Redemption payment at end of half-year.
$\frac{1}{2}$	\$97,199.28	\$1,943.99	\$1,500.00	\$443.99	0.00
1	97,643.27	1,952.87	1,500.00	452.87	0.00
$1\frac{1}{2}$	98,096.14	1,961.92	1,500.00	461.92	0.00
2	98,558.06	1,971.16	1,500.00	471.16	0.00
$2\frac{1}{2}$	99,029.22	1,980.58	1,500.00	480.58	0.00
3	99,509.80	1,990.20	1,500.00	490.20	\$100,000.00
Totals	590,035.77	11,800.72	9,000.00	2,800.72	100,000.00

In this case the holder has an initial investment of \$97,199.28, and at the end of the first half-year 2 per cent interest, or \$1,943.99, is due. The dividend payment of \$1,500.00, then made on the bonds, is *not sufficient* to provide for this interest, and the difference of \$443.99 is added to the principal and determines the *book value* at the beginning of the second half-year. This is called the *accumulation* or *writing on* of discount. By continuing this process for three years the entire discount of \$2,800.72 is written on the initial principal, and the book value, \$100,000, is then redeemed. The totals of the several columns may be used to check the numerical work.

Valuation of bonds redeemed in installments.—For the valuation of bonds which are not redeemed in one sum, but in a series of installments, first consider the simpler case where the dividend payments are annual and the rate of interest is the effective rate i .

Let $C_1, C_2, \dots, C_r$, denote the successive installments by which the bonds are to be redeemed;

$n_1, n_2, \dots, n_r$,

the respective number of years after which the successive installments become due;

$K_1, K_2, \dots, K_r$,

the present values, at the effective rate of interest i , of

C_1 due n_1 years hence,

C_2 due n_2 years hence,

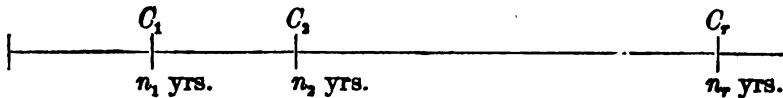
$\dots \dots \dots$

C_r due n_r years hence;

g , the fixed rate of dividend to be paid on the *outstanding* bonds;

i , the effective rate of interest employed in the valuation of the bonds, which is the *net income* rate to the purchaser;

and $A_1, A_2, \dots, A_r$, the present values, at the effective rate i , of the separate installments *with their respective dividends*.



Each installment redeemed may be regarded as furnishing a distinct problem under formula (30) so that, in order to value the entire bond issue, it may be treated as made up of r distinct issues and, after finding the value of each one, they may be added together for the value or bid on the total issue.

By formula (30) in the case of a single issue of C_1 at *net income* rate i , dividend rate g , due in n_1 years, the present value, or bid, A_1 , is:

Similarly,

$$\begin{aligned} A_1 &= K_1 + (g/i) (C_1 - K_1), \\ A_2 &= K_2 + (g/i) (C_2 - K_2), \\ &\vdots \\ A_r &= K_r + (g/i) (C_r - K_r). \end{aligned}$$

Adding,

$$(A_1 + A_2 + \dots + A_r) = (K_1 + K_2 + \dots + K_r) + (g/i)[(C_1 + C_2 + \dots + C_r) - (K_1 + K_2 + \dots + K_r)].$$

The total sum to be redeemed, $C_1 + C_2 + \dots + C_r$, is denoted by C ; the total present value of C_1 in n_1 years, C_2 in n_2 years, and so on, which by definition is equal to $K_1 + K_2 + \dots + K_r$, by K ; and the total value of the issue, $A_1 + A_2 + \dots + A_r$, by A ; then for the bid there results

$$\mathbf{A} = \mathbf{K} + (g/i) (\mathbf{C} - \mathbf{K}), \quad (36)$$

and for the premium,

$$\mathbf{A} - \mathbf{C} = (\mathbf{C} - \mathbf{K})(\mathbf{g} - \mathbf{i})/\mathbf{i}. \quad (37)$$

It thus appears that formulas (30) and (31), which were derived before for the case of a bond issue redeemed in one sum, hold also for the more general issue redeemed in any number of installments.

Installment bonds when total sum to be redeemed is 1.—When 1 is the total sum to be redeemed, that is, when $C=1$, formula (37) becomes

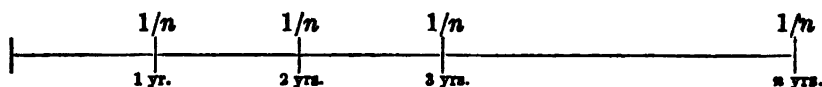
$$A-1=(1-K)(g-i)/i, \quad (38)$$

where A is the value of each unit of the sum to be redeemed, and K is the present value of the various parts of the unit at effective rate i due in $n_1, n_2, \dots, n_r$ years. Letting $A = 1 - k$, formula (38) becomes

$$k = (1 - K) (g - i) / i. \quad (39)$$

The premium is positive if g is greater than i , and negative, or a discount, if g is less than i ; for the first factor $(1 - K)$ can not be negative, as K by definition is the *present value* of a series of future payments whose sum is 1, and hence their present discounted value must be less than 1. This shows in all cases that a bond issue must be bought at a *premium*, if it is valued at a *lower* rate i than the rate of dividend g ; and at a *discount*, if it is valued at a *higher* rate i than the rate of dividend g .

Serial bonds.—To apply the general formula (39) to the case of a bond issue redeemed by n equal annual installments, consider a unit of the total sum to be redeemed. Since this unit is to be redeemed in n equal installments over n years, the annual portion redeemed is $1/n$.



The present value, K , of these n installments is clearly the value of an annuity of annual rent $1/n$; hence

$$K = a_{\overline{n}|i} \times 1/n = a_{\overline{n}|i}/n.$$

Substituting this value of K in formula (39), the following formula is obtained:

$$k = (1 - a_{\overline{n}|i}/n) (g - i) / i. \quad (40)$$

Example 19.—What is the bid on \$100,000 highway 4% serial bonds maturing in 20 equal annual installments, to net the purchaser an effective rate of 3%?

Here $n=20$, $g=.04$, $i=.03$, and $a_{\overline{20}|.03} = 14.8774749$; consequently

$$\begin{aligned} k &= (1 - 14.8774749/20)(.04 - .03)/.03 \\ &= (1 - .743873745) \times 1/3 = .256126255 \times 1/3 = .085375418. \end{aligned}$$

Hence the bid on \$100,000 is

$$1.085375418 \times \$100,000 = \$108,537.54.$$

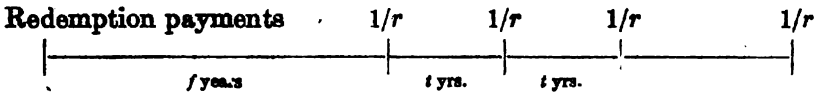
Extension of formulas to case when dividends are payable and interest is convertible m times per annum.—Formula (36) assumes that dividends are payable once a year and that the effective rate of interest is i per annum. Replacing *year* by *interval* and assuming dividends to be paid at the end of each interval and the rate of interest realized by the investor a nominal rate convertible m times a year, formula (36) still applies, if the present value K of the several

installments to be redeemed is calculated at the effective rate j/m per interval, and the dividend per unit of the sum to be redeemed is taken at the rate g/m per interval. The formula is unchanged in form since m cancels out in the ratio g/m to j/m .

General formula for valuation of bonds.—Assume that:

1. The bonds are redeemed in r equal installments.
2. The first redemption of bonds is made at the end of f years.
3. The remaining $r-1$ bond redemptions are made at intervals of t years.
4. The annual rate of dividend is g paid in m equal installments.
5. The bond issue is valued at the nominal rate $j_{(m)}$.

First find the present value, A , of an issue of the above type where $C=1$. The value of a similar total issue of C is then found by multiplying A by C . Since the unit fund is redeemed in r equal installments, each one will be $1/r$.



The total term of the issue is seen to be $f + (r-1)t$ years. As in preceding extension of formulas when dividends are payable and interest is convertible m times per annum, apply formula (36) to each installment of $1/r$ in the unit issue and the formula for the value of k , the premium per unit of the total sum to be redeemed, may readily be obtained. Expressed in terms of annuities, it appears as follows:

$$k = \left[1 - \frac{a_{m(f+tr)} - a_{mf}}{ra_{m|j}} \right] (g-j)/j \quad \text{at rate } j/m. \quad (41)$$

The annuity present values in this formula must be computed at the rate of interest j/m . The most common case in practice is where the dividends are paid semiannually. Here $m=2$, and formula (41) becomes:

$$k = \left[1 - \frac{a_{2(f+tr)} - a_{2f}}{ra_{2|j}} \right] (g-j)/j \quad \text{at rate } j/2. \quad (42)$$

The last two formulas are very general in their application and have the advantage that when employed in practical computations it is necessary to consult only a table of values of a_n .

Example 20.—To find the bid on \$1,100,000 highway bonds, interest 5% payable semiannually, dated January 1, 1914, maturing \$100,000 on January 1, 1922, 1924, 1926, 1928, 1930, 1932, 1934, 1936, 1938, 1940, and 1942, to net the purchaser a nominal rate of 4%, compounded semiannually, on his investment.

Here $f=8$, $t=2$, $r=11$, $g=.05$, $m=2$, and $j_{(2)}=.04$. Accordingly, $m(f+tr)=60$, $mf=16$, and $mt=4$. Substituting in formula (42),

$$k = \left[1 - \frac{a_{60} - a_{16}}{11 \times a_{2|j}} \right] (.05 - .04)/.04 \quad \text{at } 2\%.$$

Entering Table 35 with 2% for the values of the annuities and numbering the successive steps for convenience of explanation, the calculation may be outlined as follows:

$$\begin{aligned}
 a_{\overline{m}|i} &= 34.7608867 & (1) \\
 a_{\overline{n}|i} &= 13.5777093 & (2) \\
 a_{\overline{m}|i} - a_{\overline{n}|i} &= 21.1831774 & (3) \\
 (3) \div 11 &= 1.9257434 & (4) \\
 \therefore a_{\overline{1}|i} &= 3.8077287 \\
 (4) \div a_{\overline{1}|i} &= .5057460 & (5) \\
 \text{Complement of (5)} &= 1 - (5) = .4942540 & (6) = \text{first factor} \\
 (.05 - .04) / .04 &= .25 & (7) = \text{second factor} \\
 k &= (6) \times (7) = .1235635.
 \end{aligned}$$

The bid on one dollar is $1 + k = 1.1235635$; consequently the bid on the whole issue is

$$1.1235635 \times \$1,100,000 = \$1,235,919.85.$$

Example 21.—To find the price of \$100,000 highway bonds, interest 5%, semi-annual, dated January 1, 1914, maturing \$50,000 January 1, 1917, and \$50,000 January 1, 1919, to net the investor 4% compounded semiannually.

In this case $f=3$, $r=2$, $t=2$, $m=2$, $g=.05$, $j=.04$, and, substituting as in the preceding example, the required price is found to be \$103,646.00. The progress of the loan is indicated in the following schedule.

SCHEDULE V.

Year.	Book value or principal at beginning of half-year.	Semiannual interest of 2%.	Semiannual dividend of $\frac{5}{2}$ % on bonds.	Amortisation of premium at end of half-year.	Redemption payment at end of half-year.
$\frac{1}{2}$	\$103,646.00	\$2,072.92	\$2,500.00	\$427.08	0.00
1	103,218.92	2,064.38	2,500.00	435.62	0.00
$1\frac{1}{2}$	102,783.30	2,055.67	2,500.00	444.33	0.00
2	102,338.97	2,046.78	2,500.00	453.22	0.00
$2\frac{1}{2}$	101,885.75	2,037.72	2,500.00	462.28	0.00
3	101,423.47	2,028.47	2,500.00	471.53	\$50,000.00
$3\frac{1}{2}$	50,951.94	1,019.04	1,250.00	230.96	0.00
4	50,720.98	1,014.42	1,250.00	235.58	0.00
$4\frac{1}{2}$	50,485.40	1,009.71	1,250.00	240.29	0.00
5	50,245.11	1,004.89	1,250.00	245.11	50,000.00
Totals	817,699.84	16,354.00	20,000.00	3,646.00	100,000.00

Extension of term of tables.—It sometimes happens in applying formula (42) that the value of $2(f+tr)$ is greater than the term given in the tables. In example 20 one of the required annuity values was $a_{\overline{m}|i}$ but, if the interval between redemptions had been three years instead of two, $2(f+tr) = 82$ would have called for the value of an annuity $a_{\overline{m}|i}$ beyond the limits of the tables. It is easy, however, to extend these limits by making use of the following obvious relations:

$$v^{m+n} = v^m v^n, \quad (43)$$

$$(1+i)^{m+n} = (1+i)^m (1+i)^n, \quad (44)$$

$$a_{\overline{m+n}|i} = [1 - v^{m+n}] / i, \quad (45)$$

$$a_{\overline{m+n}|i} = a_{\overline{m}|i} + v^m a_{\overline{n}|i}, \quad (46)$$

$$s_{\overline{m+n}|i} = [(1+i)^m (1+i)^n - 1] / i, \quad (47)$$

$$s_{\overline{m+n}|i} = (1+i)^n s_{\overline{m}|i} + s_{\overline{n}|i}. \quad (48)$$

Example 22.—To find $s_{\overline{60}|1\frac{1}{2}\%$ when the limit of the tables is 60 years or terms. Applying formula (47) there results

$$s_{\overline{60}|1\frac{1}{2}\%} = \frac{(1.015)^{60+24} - 1}{.015} = \frac{(1.015)^{84} \times (1.015)^{24} - 1}{.015}$$

$$= \frac{2.4432198 \times 1.6589964 - 1}{.015} = 203.5528568.$$

By formula (48)

$$s_{\overline{60}|1\frac{1}{2}\%} = (1.015)^{24} \cdot s_{\overline{60}|1\frac{1}{2}\%} + s_{\overline{24}|1\frac{1}{2}\%}$$

$$= 1.6589964 \times 96.2146517 + 43.9330915 = 203.5528563.$$

The correct value of $s_{\overline{60}|1\frac{1}{2}\%$ at 1½% to seven places of decimals is 203.5528497; so the above method may be regarded as giving the correct value to about five places of decimals. In most practical cases this will be sufficiently accurate.

Valuation of serial bonds bearing semiannual dividends.—The most common type of serial bond bears semiannual dividends and is redeemed in equal *annual* installments, the first of which is paid at the end of the first year. Formula (42) lends itself directly to the valuation of this bond at a nominal rate of interest j convertible twice a year. In this case $f=t=1$, $r=n$, and

$$k = \left[1 - \frac{a_{\overline{n}|i} - a_{\overline{1}|i}}{n a_{\overline{1}|i}} \right] (g - j) / j \quad \text{at rate } j/2. \quad (49)$$

Formula (49) requires the use of a table of values of $a_{\overline{n}|i}$ only. It can be put in another convenient form for computation involving the use of a table of values of $a_{\overline{n}|i}$ and $s_{\overline{n}|i}$. For, by formula (46), $a_{\overline{1}|i} = a_{\overline{1}|i} + v^2 a_{\overline{n}|i}$, and, since $v^2/a_{\overline{1}|i} = 1/(1+i)^2 a_{\overline{1}|i} = 1/s_{\overline{1}|i}$, after a simple reduction, there results

$$k = \left[1 - \frac{a_{\overline{n}|i}}{n s_{\overline{1}|i}} \right] (g - j) / j \quad \text{at rate } j/2. \quad (50)$$

Example 23.—\$300,000 highway serial bonds bearing 4% interest payable semi-annually, dated January 1, 1914, mature \$100,000 January 1, 1915, 1916, and 1917. What price should be paid to realize a net income of 3% compounded semiannually?

Here $n=3$, $g=.04$, $j_{(2)}=.03$, and by formula (49)

$$k = \left[1 - \frac{a_{\overline{3}|i}}{3 a_{\overline{1}|i}} \right] (.04 - .03) / .03 \quad \text{at } 1\frac{1}{2}\%$$

$$= .0575373 \times 1/3 = .0191791,$$

therefore the price to earn 3% compounded semiannually is

$$.0191791 \times \$300,000 = \$305,753.73.$$

The following schedule illustrates the progress of this loan.

SCHEDULE VI.

Year.	Book value or principal at beginning of half-year.	Semiannual interest of 1½%.	Semiannual dividend of 2% on bonds.	Amortization of premium at end of half-year.	Redemption payment at end of half-year.
$\frac{1}{2}$	\$305, 753. 73	\$4, 586. 31	\$6, 000. 00	\$1, 413. 69	- 0. 00
1	304, 340. 04	4, 565. 10	6, 000. 00	1, 434. 90	\$100, 000. 00
$1\frac{1}{2}$	202, 905. 14	3, 043. 58	4, 000. 00	956. 42	0. 00
2	201, 948. 72	3, 029. 23	4, 000. 00	970. 77	100, 000. 00
$2\frac{1}{2}$	100, 977. 95	1, 514. 67	2, 000. 00	485. 33	0. 00
3	100, 492. 62	1, 507. 38	2, 000. 00	492. 62	100, 000. 00
Totals	1, 216, 418. 20	18, 246. 27	24, 000. 00	5, 753. 73	300, 000. 00

Annuity bonds.—On pages 317 to 320 the operation of a loan where both principal and interest are discharged by equal installments is fully described. It is evident that bonds may be issued on this basis and retired in accordance with the principal repayments contained in the annuity installments. Since these principal repayments are not exact multiples of the amounts or denominations in which bonds are usually issued, it is necessary to adjust the *exact* schedule so as to meet this requirement. The adjusted schedule gives an issue in which the bonds are retired year by year in increasing amounts.

To finance a loan of L by an issue of annuity bonds bearing interest or dividends at rate g per annum.—The annual installment which will retire the bonds in n years and at the same time pay interest at the rate of g per cent on outstanding bonds is

$$L/a_{\overline{n}|g} \quad \text{at rate } g. \quad (51)$$

If the bonds are to bear interest of g per cent per annum, payable in p installments of g/p per cent during the year, then

$$L/a_{\overline{np}|g/p} \quad \text{at rate } g/p \quad (52)$$

is the periodical payment or annuity installment which will take care of interest on the bonds and retire them in n years.

Example 24.—Adjust Schedule I, page 318 to finance the same loan by an annuity bond issue of \$100,000, denomination \$100, bearing 5% interest, compounded semi-annually, and retired in three years by six equal (nearly) semiannual annuity installments.

Referring to Schedule I on page 318 the adjustments in the last column to even multiples of \$100 are easily made; a check on this work is that the adjusted column must foot up to \$100,000. When the column of bond redemptions is decided upon, the other columns in the schedule are readily derived.

SCHEDULE VII.

(Schedule I adjusted to bonds of denomination \$100.)

Year.	Book value or principal at beginning of half-year.	Semiannual interest of 2½%.	Annuity installments at end of half-year.	Amortization of premium at end of half-year.	Amount of bonds retired at end of half-year.
$\frac{1}{2}$	\$100,000	\$2,500.00	\$18,200.00	0.00	\$15,700
1	84,300	2,107.50	18,107.50	0.00	16,000
$1\frac{1}{2}$	68,300	1,707.50	18,107.50	0.00	16,400
2	51,900	1,297.50	18,197.50	0.00	16,900
$2\frac{1}{2}$	35,000	875.00	18,175.00	0.00	17,300
3	17,700	442.50	18,142.50	0.00	17,700
Totals	357,200	8,930.00	108,930.00	0.00	100,000

Valuation of annuity bonds.—In order to value an issue of this character, so as to yield the purchaser a net income at a rate of interest different from the rate of dividend on the bonds, it will ordinarily be necessary to value separately the several parts of the total issue in accordance with the respective dates on which they are retired. This calculation may frequently be shortened by employing formula (36). Bond tables may also be consulted to advantage. The following example and schedule respectively illustrate the calculation of the bid and progress of the loan.

Example 25.—Determine the bid on the entire issue of annuity bonds in Example 24 so as to yield the investor a net income of 4%, compounded semiannually.

Applying formula (35) successively to the several bond issues in the order in which they are retired with $g=.05$ and $j=.04$, the following premiums are found:

\$76.96
155.32
236.48
321.75
407.71
495.73

\$1,693.95

Accordingly, the bid on the entire issue is \$101,693.95. The schedule illustrating the progress of this bond issue follows. It is constructed in the same manner as preceding bond schedules and needs no additional explanation.

SCHEDULE VIII.—*Showing the progress of an annuity bond issue of \$100,000, denomination \$100, bearing 5 per cent interest, compounded semiannually, and retired in three years by six equal (nearly) semiannual annuity installments. Bought to yield the investor 4 per cent, compounded semiannually.*

Year.	Book value or principal at beginning of half-year.	Semiannual interest of 2½%.	Annuity installments at end of half-year.	Amortization of premium at end of half-year.	Amount of bonds retired at end of half-year.
$\frac{1}{2}$	\$101,693.95	\$2,033.88	\$18,200.00	\$468.12	\$15,700
1	85,527.83	1,710.56	18,107.50	398.94	16,000
$1\frac{1}{2}$	69,130.89	1,382.62	18,107.50	324.88	16,400
2	52,408.01	1,048.12	18,197.50	249.38	16,900
$2\frac{1}{2}$	35,256.63	705.13	18,175.00	169.87	17,300
3	17,786.76	355.74	18,142.50	86.76	17,700
Totals	361,802.07	7,236.05	108,930.00	1,693.95	100,000

TABLE 31.—The accumulation of 1 at the end of n years.

$$s^n = (1+i)^n.$$

Years.	1½%.	1¾%.	2%.	2¼%.	2½%.	2¾%.	3%.	Years.
1	1.0150000	1.0175000	1.0200000	1.0225000	1.0250000	1.0275000	1.0300000	1
2	1.0302250	1.0353063	1.0404000	1.0455063	1.0506250	1.0557563	1.0609000	2
3	1.0456784	1.0534241	1.0612080	1.0690301	1.0768906	1.0847896	1.0927270	3
4	1.0613636	1.0718166	1.0824322	1.0930833	1.1038129	1.1146213	1.1255088	4
5	1.0772840	1.0906166	1.1040808	1.1176777	1.1314082	1.1452738	1.1592741	5
6	1.0934433	1.1097024	1.1261624	1.1428254	1.1596984	1.1767794	1.1940623	6
7	1.1098449	1.1291223	1.1486857	1.1688390	1.1896858	1.2012365	1.2236739	7
8	1.1264926	1.1488818	1.1716594	1.1948311	1.2184029	1.2423806	1.2667701	8
9	1.1433900	1.1689672	1.1950026	1.2217148	1.2488630	1.2765480	1.3047732	9
10	1.1605406	1.1894454	1.2189944	1.2492034	1.2800845	1.3116510	1.3439164	10
11	1.1779489	1.2102566	1.2433743	1.2773105	1.3120867	1.3477314	1.3842339	11
12	1.1956182	1.2314398	1.2662318	1.3019050	1.3448886	1.3847888	1.4257609	12
13	1.2135524	1.2526965	1.2936066	1.3354261	1.3785110	1.4233803	1.4683337	13
14	1.2317567	1.2749168	1.3194788	1.3654834	1.4129738	1.4619941	1.5128867	14
15	1.2502321	1.2972279	1.3458683	1.3962068	1.4482962	1.5021990	1.5596764	15
16	1.2689856	1.3196294	1.3727857	1.4276215	1.4845056	1.5477314	1.6047084	16
17	1.2880203	1.3430281	1.4002414	1.4597429	1.5216183	1.5859860	1.6482476	17
18	1.3073406	1.3665311	1.4282463	1.4826722	1.5596587	1.6293897	1.7024331	18
19	1.3269498	1.3904454	1.4568112	1.5061704	1.5986502	1.6743829	1.7583061	19
20	1.3468550	1.4147782	1.4859474	1.5308092	1.6386164	1.7204284	1.8061112	20
21	1.3670578	1.4396368	1.5159663	1.5566207	1.6795819	1.7677402	1.8609946	21
22	1.3875637	1.4647287	1.5459797	1.6312221	1.7215714	1.8163531	1.9161034	22
23	1.4083773	1.4903615	1.5768998	1.6682314	1.7646107	1.8663028	1.9735863	23
24	1.4295028	1.5164428	1.6084378	1.7087696	1.8087280	1.9176361	2.0327941	24
25	1.4509454	1.5429805	1.6406060	1.7441483	1.8539441	1.9703608	2.0937779	25
26	1.4727085	1.5699827	1.6734181	1.7833896	1.9002927	2.0245458	2.1569193	26
27	1.4948002	1.5974574	1.7068865	1.8235159	1.9478000	2.0802206	2.2212890	27
28	1.5172222	1.6254129	1.7410242	1.8645450	1.9964950	2.1374368	2.2879277	28
29	1.5399805	1.6538576	1.7758447	1.9064973	2.0464074	2.1962061	2.3568565	29
30	1.5630902	1.6828201	1.8113616	1.9493934	2.0975676	2.2566017	2.4272625	30
31	1.5865264	1.7122491	1.8475886	1.9932548	2.1500068	2.3186593	2.5000804	31
32	1.6103243	1.7422135	1.8845406	2.0381030	2.2037590	2.3824214	2.5750828	32
33	1.6344702	1.7727022	1.9222314	2.0839903	2.2588509	2.4479390	2.6522332	33
34	1.6589964	1.8037245	1.9606760	2.1308496	2.3153221	2.5152563	2.7319053	34
35	1.6838813	1.8352897	1.9998896	2.1787936	2.3732052	2.5844258	2.8138635	35
36	1.7091395	1.8674073	2.0398873	2.2278164	2.4325353	2.6554975	2.8982783	36
37	1.7347766	1.9000669	2.0806851	2.2779423	2.4933497	2.7285237	2.9852267	37
38	1.7607963	1.9333384	2.1222988	2.3291980	2.5556824	2.8035581	3.0747835	38
39	1.7872103	1.9671718	2.1647448	2.3816029	2.6196745	2.8806590	3.1670270	39
40	1.8140184	2.0015973	2.2080897	2.4351890	2.6856638	2.9598740	3.2620378	40
41	1.8412357	2.0366253	2.2523005	2.4899807	2.7521904	3.0413705	3.3609889	41
42	1.8688471	2.0722662	2.2977445	2.5460053	2.8200962	3.1249055	3.4620959	42
43	1.8968798	2.1085309	2.3431894	2.6033904	2.8915201	3.2108404	3.5645168	43
44	1.9253330	2.1454302	2.3900631	2.6618944	2.9638081	3.2991385	3.6714322	44
45	1.9542130	2.1829752	2.4378542	2.7217564	3.0379083	3.3898648	3.7815958	45
46	1.9835262	2.2211773	2.4866113	2.7829959	3.1138509	3.4830661	3.8950437	46
47	2.0132791	2.2600479	2.5363435	2.8456133	3.1919971	3.5788709	4.0118960	47
48	2.0434783	2.2995987	2.5870704	2.9098396	3.2714896	3.6772899	4.1322519	48
49	2.0741305	2.3398417	2.6388118	2.9751065	3.3532768	3.7784154	4.2562194	49
50	2.1052424	2.3807859	2.6915890	3.0420464	3.4371067	3.8823218	4.3839090	50
51	2.1368211	2.4224527	2.7454196	3.1104624	3.5230864	3.9909656	4.5154232	51
52	2.1688724	2.4648457	2.8003282	3.1804785	3.6111124	4.0987855	4.6508598	52
53	2.2014065	2.5079805	2.8563348	3.2520893	3.7013902	4.2115021	4.7904125	53
54	2.2344276	2.5518701	2.9134614	3.3252102	3.7939249	4.3273184	4.9341349	54
55	2.2679440	2.5965279	2.9717307	3.4000274	3.8887730	4.4463196	5.0821486	55
56	2.3019631	2.6419671	3.0311653	3.4763280	3.9859924	4.5686994	5.2346121	56
57	2.3364896	2.6882015	3.0917896	3.5547499	4.0856432	4.6943296	5.3916514	57
58	2.3715400	2.7352450	3.1566244	3.6347318	4.1877832	4.8232311	5.5534010	58
59	2.4071181	2.7831118	3.2166969	3.7165132	4.2924778	4.9556924	5.7200030	59
60	2.4432198	2.8318163	3.2810908	3.8001348	4.3997597	5.0922514	5.8916081	60

TABLE 31.—The accumulation of 1 at the end of n years—Continued.

$$s^n = (1+i)^n.$$

Years.	3½%.	4%.	4½%.	5%.	5½%.	6%.	7%.	Years.
1	1.0850000	1.0400000	1.0450000	1.0500000	1.0550000	1.0600000	1.0700000	1
2	1.0712260	1.0816000	1.0920250	1.1025000	1.1130250	1.1236000	1.1449000	2
3	1.1087179	1.1248640	1.1411661	1.1576250	1.1742414	1.1910180	1.2280430	3
4	1.1475230	1.1668586	1.1925186	1.2155063	1.2388247	1.2624770	1.3107960	4
5	1.1876663	1.2166629	1.2461819	1.2762816	1.3069600	1.3382256	1.4025517	5
6	1.2292553	1.2653190	1.3022601	1.3400956	1.3788428	1.4185191	1.5007304	6
7	1.2723798	1.3159818	1.3560618	1.4071004	1.4546792	1.5036308	1.6057815	7
8	1.3180900	1.3685601	1.4221006	1.4774554	1.5346985	1.5939481	1.7181863	8
9	1.3653974	1.4238113	1.4869051	1.5513282	1.6190643	1.6894790	1.8384502	9
10	1.4150968	1.4802448	1.5529694	1.6289946	1.7081445	1.7908477	1.9671514	10
11	1.4680907	1.5394541	1.6226531	1.7103394	1.8020624	1.8962966	2.1048530	11
12	1.5111037	1.6010232	1.6968814	1.7958563	1.9012075	2.0121965	2.2821916	12
13	1.5568661	1.6660735	1.7721961	1.8564911	2.0057736	2.1302283	2.4096450	13
14	1.6189945	1.7357655	1.8519449	1.9799816	2.1160615	2.2606040	2.5785342	14
15	1.6789438	1.8009435	1.9262324	2.0786232	2.2324765	2.3965582	2.7508115	15
16	1.7369690	1.8726813	2.0223702	2.1826746	2.3526227	2.5426517	2.9421688	16
17	1.7947756	1.9473005	2.1133768	2.2920183	2.4849022	2.6927728	3.1585132	17
18	1.8574892	2.0258165	2.2094788	2.4068192	2.6214663	2.8543892	3.3799832	18
19	1.92225013	2.1089492	2.3078608	2.5269502	2.7654646	3.0265095	3.6168275	19
20	1.9897899	2.1911231	2.4117140	2.6532977	2.9177575	3.2071355	3.8690845	20
21	2.0604315	2.2787681	2.5202412	2.7859626	3.0782342	3.4066636	4.1451529	21
22	2.1351516	2.3699188	2.6336520	2.9262607	3.2475370	3.6253374	4.4304017	22
23	2.2061145	2.4647155	2.7521064	3.0715238	3.4261516	3.8197497	4.7408299	23
24	2.2833285	2.5633042	2.8760128	3.2250909	3.6145999	4.0496464	5.0723670	24
25	2.3682450	2.6658363	3.0064345	3.3863549	3.8138624	4.2918707	5.4274336	25
26	2.4502661	2.7724696	3.1406790	3.5556727	4.0231280	4.5681830	5.7973529	26
27	2.5315671	2.8836686	3.2820066	3.7334563	4.2444010	4.8223459	6.2138676	27
28	2.6201720	2.9987000	3.4297000	3.9201291	4.4778431	5.1166667	6.6488384	28
29	2.7115780	3.1186151	3.5840365	4.1161356	4.7241244	5.4188379	7.1142571	29
30	2.8067937	3.2433675	3.7453151	4.3219424	4.9839513	5.7434912	7.6122550	30
31	2.9050815	3.3731334	3.9138575	4.5380395	5.2580696	6.0881006	8.1451129	31
32	3.0067076	3.5080588	4.0999810	4.7649415	5.5472824	6.4533967	8.7152708	32
33	3.1119424	3.6483811	4.2740302	5.0031835	5.8323618	6.8509899	9.3253398	33
34	3.2208608	3.7943163	4.4638315	5.2539490	6.1242417	7.2810253	9.9781135	34
35	3.3335905	3.9460690	4.6673478	5.5160154	6.5138250	7.6909688	10.6765815	35
36	3.4502661	4.1039326	4.8773785	5.7918161	6.8720654	8.1472520	11.4230422	36
37	3.5710254	4.2680899	5.0969605	6.0814096	7.2500601	8.6390371	12.2286181	37
38	3.6960113	4.4388135	5.3262192	6.3854773	7.6489028	9.1542324	13.0792714	38
39	3.8253717	4.6163680	5.5658961	6.7047512	8.0804870	9.7035075	13.9948204	39
40	3.9592597	4.8010206	5.8163645	7.0399657	8.5133088	10.2857179	14.9744578	40
41	4.0978338	4.9930615	6.0781009	7.3919682	8.9615408	10.9029610	16.0226699	41
42	4.2412580	5.1927839	6.3516155	7.7615876	9.4755255	11.5570327	17.1442568	42
43	4.3897020	5.4004983	6.6374382	8.1496696	9.9966794	12.2504546	18.3443548	43
44	4.5433416	5.6165151	6.9361229	8.5571503	10.5464698	12.9854819	19.6284596	44
45	4.7023586	5.8411757	7.2482494	8.9850078	11.1265641	13.7646108	21.0094518	45
46	4.8669411	6.0748227	7.5744196	9.4342582	11.7885146	14.5904875	22.4726224	46
47	5.0372840	6.3178156	7.9182385	9.9059711	12.4841320	15.4680167	24.0457070	47
48	5.2158930	6.5706282	8.2744556	10.4012697	13.0852602	16.3938717	25.7289065	48
49	5.3980646	6.8333494	8.6436711	10.9213331	13.7838485	17.3775040	27.5269900	49
50	5.5849298	7.1066369	9.0263363	11.4673698	14.5419612	18.4201543	29.4570261	50
51	5.7808093	7.3909507	9.4910499	12.0407698	15.3417091	19.5233635	31.5190168	51
52	5.9837133	7.6865867	9.9339646	12.6428063	16.1855664	20.6968853	33.7263490	52
53	6.1921082	7.9940323	10.3749487	13.2749487	17.0757725	21.9389985	36.0861254	53
54	6.4068230	8.3128144	10.7715868	13.9389661	18.0149400	23.2550204	38.6121509	54
55	6.6381411	8.6463669	11.2563062	14.6363609	19.0057617	24.6502216	41.3150015	55
56	6.8859011	9.0222216	11.7828420	15.3674125	20.0510786	26.1293409	44.2076616	56
57	7.1065936	9.3519105	12.3621699	16.1367831	21.1588579	27.6971013	47.3015452	57
58	7.3428322	9.7356869	12.8453176	16.9425724	22.3178518	29.3586272	50.6126534	58
59	7.6118230	10.1150264	13.4233569	17.7897009	23.5448061	31.1204631	54.1553391	59
60	7.8730909	10.5192774	14.0274079	18.6971856	24.8397705	32.9876909	57.9464268	60

TABLE 32.—The accumulation of an annuity of 1 per annum at the end of *n* years.

$$s_n = \frac{(1+i)^n - 1}{i}$$

Years	1½%	1½%	2%	2½%	3%	3½%	4%	Years
1	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1
2	2.015000	2.017500	2.020000	2.022500	2.025000	2.027500	2.030000	2
3	3.046250	3.052500	3.058750	3.065000	3.071250	3.077500	3.083750	3
4	4.095000	4.103250	4.111500	4.119750	4.128000	4.136250	4.144500	4
5	5.152500	5.162500	5.172500	5.182500	5.192500	5.202500	5.212500	5
6	6.220000	6.232500	6.245000	6.257500	6.270000	6.282500	6.295000	6
7	7.292500	7.307500	7.322500	7.337500	7.352500	7.367500	7.382500	7
8	8.365000	8.382500	8.397500	8.412500	8.427500	8.442500	8.457500	8
9	9.437500	9.457500	9.472500	9.487500	9.502500	9.517500	9.532500	9
10	10.500000	10.522500	10.545000	10.567500	10.590000	10.612500	10.635000	10
11	11.562500	11.587500	11.612500	11.637500	11.662500	11.687500	11.712500	11
12	12.625000	12.652500	12.680000	12.707500	12.735000	12.762500	12.790000	12
13	13.687500	13.717500	13.747500	13.777500	13.807500	13.837500	13.867500	13
14	14.750000	14.782500	14.815000	14.847500	14.880000	14.912500	14.945000	14
15	15.812500	15.847500	15.882500	15.917500	15.952500	15.987500	16.022500	15
16	16.875000	16.912500	16.950000	16.987500	17.025000	17.062500	17.100000	16
17	17.937500	17.977500	18.017500	18.057500	18.097500	18.137500	18.177500	17
18	18.990000	19.032500	19.075000	19.117500	19.160000	19.202500	19.245000	18
19	20.042500	20.087500	20.132500	20.177500	20.222500	20.267500	20.312500	19
20	21.095000	21.142500	21.190000	21.237500	21.285000	21.332500	21.380000	20
21	22.147500	22.197500	22.247500	22.297500	22.347500	22.397500	22.447500	21
22	23.200000	23.252500	23.305000	23.357500	23.410000	23.462500	23.515000	22
23	24.252500	24.307500	24.362500	24.417500	24.472500	24.527500	24.582500	23
24	25.305000	25.362500	25.420000	25.477500	25.535000	25.592500	25.650000	24
25	26.357500	26.417500	26.477500	26.537500	26.597500	26.657500	26.717500	25
26	27.410000	27.472500	27.535000	27.597500	27.660000	27.722500	27.785000	26
27	28.462500	28.527500	28.592500	28.657500	28.722500	28.787500	28.852500	27
28	29.515000	29.582500	29.650000	29.717500	29.785000	29.852500	29.920000	28
29	30.567500	30.637500	30.707500	30.777500	30.847500	30.917500	30.987500	29
30	31.620000	31.692500	31.765000	31.837500	31.910000	31.982500	32.055000	30
31	32.672500	32.747500	32.822500	32.897500	32.972500	33.047500	33.122500	31
32	33.725000	33.802500	33.880000	33.957500	34.035000	34.112500	34.190000	32
33	34.777500	34.857500	34.937500	35.017500	35.097500	35.177500	35.257500	33
34	35.830000	35.912500	35.995000	36.077500	36.160000	36.242500	36.325000	34
35	36.882500	36.967500	37.052500	37.137500	37.222500	37.307500	37.392500	35
36	37.935000	38.022500	38.110000	38.197500	38.285000	38.372500	38.460000	36
37	38.987500	39.077500	39.167500	39.257500	39.347500	39.437500	39.527500	37
38	40.040000	40.132500	40.225000	40.317500	40.410000	40.502500	40.595000	38
39	41.092500	41.187500	41.282500	41.377500	41.472500	41.567500	41.662500	39
40	42.145000	42.242500	42.340000	42.437500	42.535000	42.632500	42.730000	40
41	43.197500	43.297500	43.397500	43.497500	43.597500	43.697500	43.797500	41
42	44.250000	44.352500	44.455000	44.557500	44.660000	44.762500	44.865000	42
43	45.302500	45.407500	45.512500	45.617500	45.722500	45.827500	45.932500	43
44	46.355000	46.462500	46.570000	46.677500	46.785000	46.892500	47.000000	44
45	47.407500	47.517500	47.627500	47.737500	47.847500	47.957500	48.067500	45
46	48.460000	48.572500	48.685000	48.797500	48.910000	49.022500	49.135000	46
47	49.512500	49.627500	49.742500	49.857500	49.972500	50.087500	50.202500	47
48	50.565000	50.682500	50.800000	50.917500	51.035000	51.152500	51.270000	48
49	51.617500	51.737500	51.857500	51.977500	52.097500	52.217500	52.337500	49
50	52.670000	52.792500	52.915000	53.037500	53.160000	53.282500	53.405000	50
51	53.722500	53.847500	53.972500	54.097500	54.222500	54.347500	54.472500	51
52	54.775000	54.902500	55.030000	55.157500	55.285000	55.412500	55.540000	52
53	55.827500	55.957500	56.087500	56.217500	56.347500	56.477500	56.607500	53
54	56.880000	57.012500	57.145000	57.277500	57.410000	57.542500	57.675000	54
55	57.932500	58.067500	58.202500	58.337500	58.472500	58.607500	58.742500	55
56	58.985000	59.122500	59.260000	59.397500	59.535000	59.672500	59.810000	56
57	60.037500	60.177500	60.317500	60.457500	60.597500	60.737500	60.877500	57
58	61.090000	61.232500	61.375000	61.517500	61.660000	61.802500	61.945000	58
59	62.142500	62.287500	62.432500	62.577500	62.722500	62.867500	63.012500	59
60	63.195000	63.342500	63.490000	63.637500	63.785000	63.932500	64.080000	60

TABLE 32.—The accumulation of an annuity of 1 per annum at the end of n years—Con.

$$s_n = \frac{(1+i)^n - 1}{i}$$

Yrs.	3½%.	4%.	4½%.	5%.	5½%.	6%.	7%.	Yrs.
1	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1
2	2.068000	2.080000	2.095000	2.095000	2.065000	2.060000	2.070000	2
3	3.168250	3.121000	3.137025	3.152000	3.168000	3.153000	3.149000	3
4	4.314640	4.246400	4.278191	4.310125	4.342264	4.374610	4.430030	4
5	5.506860	5.416800	5.470707	5.535313	5.581091	5.637030	5.760790	5
6	6.755132	6.639755	6.710891	6.801912	6.888051	6.975315	7.153207	6
7	7.779475	7.596245	7.679151	7.814200	7.908998	8.006377	8.284011	7
8	8.981885	8.714263	8.800103	8.949109	9.121570	9.307479	9.689026	8
9	10.369456	10.052795	10.202113	11.026543	11.256595	11.491310	11.977988	9
10	11.781383	12.006107	12.283204	12.577825	12.873338	13.180749	13.816480	10
11	13.141991	13.495314	13.841178	14.206787	14.583493	14.971626	15.783898	11
12	14.601961	15.028065	15.444018	15.671265	16.385597	16.809941	17.889413	12
13	16.113003	16.639877	17.159913	17.712630	18.296791	18.892177	20.140620	13
14	17.676908	18.201912	18.821094	19.596830	20.292572	21.015059	22.550479	14
15	19.296800	20.728576	20.784043	21.578586	22.408635	23.780749	25.760320	15
16	20.971020	21.824811	22.719337	23.657491	24.641140	25.672821	27.889036	16
17	22.705013	23.077124	24.741706	25.840864	26.904027	28.212879	30.940217	17
18	24.499518	25.045120	26.855087	28.132847	29.481204	30.955536	33.990325	18
19	26.357180	27.771294	29.033625	30.539089	32.102671	33.799917	37.879648	19
20	28.279618	29.779786	31.371423	33.065641	34.808319	36.759912	40.964923	20
21	30.269470	31.969207	33.783136	35.719251	37.786075	39.927267	44.865168	21
22	32.339322	34.247908	36.303780	38.502144	40.864307	43.362293	49.007392	22
23	34.490417	36.617886	38.973030	41.430471	44.118467	46.965277	53.436149	23
24	36.665262	39.082041	41.699193	44.501989	47.537993	50.815774	58.176670	24
25	38.949587	41.645983	44.582102	47.727068	51.152692	54.864520	63.240877	25
26	41.313101	44.311746	47.570646	51.113438	54.965905	59.156327	68.676470	26
27	43.759002	47.084214	50.711323	54.669126	58.999104	63.705757	74.488233	27
28	46.290673	49.967530	53.903332	58.402623	63.233105	68.528116	80.697000	28
29	48.910798	52.968263	57.428332	62.322719	67.711353	73.699793	87.345528	29
30	51.626706	56.089378	61.007067	66.438847	72.435479	79.068192	94.460763	30
31	54.429471	59.326353	64.752378	70.760799	77.419429	84.801674	102.073014	31
32	57.324625	62.701467	68.666252	75.298204	82.677479	90.899780	110.215153	32
33	60.312101	66.306374	72.752263	80.063770	88.234703	97.343167	118.939425	33
34	63.483134	69.957905	77.082525	85.066694	94.077121	104.183746	128.268748	34
35	66.740127	73.682249	81.496180	90.320874	100.251368	111.437799	138.266120	35
36	70.070032	77.598139	86.163958	95.836327	106.765188	119.120867	148.913496	36
37	73.487898	81.702244	91.041343	101.628139	113.637272	127.268117	160.237420	37
38	77.088947	86.070363	96.138208	107.709458	120.887324	135.904268	172.561020	38
39	80.774000	90.609147	101.464240	114.095023	128.536127	145.058451	185.640916	39
40	84.550278	95.325517	107.038231	120.769772	136.605614	154.761956	199.636120	40
41	88.506575	99.826533	112.840876	127.839730	145.118923	165.047636	214.609508	41
42	92.607371	104.819507	118.924783	135.231751	154.100436	175.950446	230.632297	42
43	96.848608	110.012817	125.276404	142.993337	163.575091	187.507672	247.776495	43
44	101.238313	115.412870	131.913422	151.143006	173.572685	199.758031	266.120813	44
45	105.781679	121.029820	138.849651	159.700159	184.119163	212.743518	285.749308	45
46	110.484015	126.870577	146.098213	168.685137	195.245719	226.508126	306.751726	46
47	115.350072	132.945304	153.672631	178.119421	206.984239	241.068521	329.224390	47
48	120.388256	139.263200	161.587916	188.026392	219.368368	256.564288	353.270008	48
49	125.601846	145.833743	169.859852	198.426626	232.433620	272.958406	378.998995	49
50	130.997910	152.670637	178.508283	209.347067	246.217475	290.335046	406.328295	50
51	136.582570	159.773760	187.535046	220.815395	260.759437	308.750089	435.985645	51
52	142.363268	167.164717	196.974706	232.861653	276.101307	328.261424	467.504974	52
53	148.345998	174.851304	206.838341	245.498973	292.285771	348.975307	501.230319	53
54	154.538076	182.846367	217.146376	258.773922	309.362546	370.917002	537.816417	54
55	160.948896	191.158170	227.917594	272.712613	327.377656	394.717026	576.928926	55
56	167.580010	199.805399	239.174267	287.348242	346.353473	418.523493	617.243591	56
57	174.443321	208.797761	250.937106	302.715617	366.494359	444.951691	661.450547	57
58	181.550017	218.149670	263.229795	318.851448	387.588219	473.648794	708.751909	58
59	188.905300	227.875689	276.074597	335.794017	409.905656	502.007718	759.964843	59
60	196.516820	237.990832	289.497940	353.583719	433.450871	533.126130	813.520384	60

TABLE 33.—The annual sinking fund which will accumulate to 1 at the end of n years.

$$\frac{1}{s_{\overline{n}|i}} = \frac{i}{(1+i)^n - 1}$$

Years.	1½%.	1¾%.	2%.	2¼%.	2½%.	2¾%.	3%.	Years.
1	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1
2	0.4962779	0.4956630	0.4950496	0.4944376	0.4938272	0.4932183	0.4926108	2
3	0.3283830	0.3275675	0.3267547	0.3259446	0.3251372	0.3243324	0.3235304	3
4	0.2444448	0.2435324	0.2426238	0.2417189	0.2408176	0.2399206	0.2390271	4
5	0.1940898	0.1931214	0.1921584	0.1912002	0.1902469	0.1892983	0.1883546	5
6	0.1606323	0.1596226	0.1586258	0.1576360	0.1566500	0.1556708	0.1546975	6
7	0.1365652	0.1355306	0.1345120	0.1335003	0.1324954	0.1314975	0.1305064	7
8	0.1175429	0.1165098	0.1154846	0.1144674	0.1134570	0.1124530	0.1114564	8
9	0.1046098	0.1035581	0.1025164	0.1014817	0.1004549	0.0994410	0.0984339	9
10	0.0934342	0.0923753	0.0913265	0.0902877	0.0892588	0.0882397	0.0872305	10
11	0.0843938	0.0833204	0.0822779	0.0811365	0.0800100	0.0790063	0.0780075	11
12	0.0766800	0.0756138	0.0745596	0.0735174	0.0724871	0.0714687	0.0704621	12
13	0.0702404	0.0691728	0.0681184	0.0670769	0.0660483	0.0650325	0.0640295	13
14	0.0647233	0.0636556	0.0626020	0.0615623	0.0605365	0.0595246	0.0585263	14
15	0.0601944	0.0591274	0.0580774	0.0570465	0.0560306	0.0550297	0.0540438	15
16	0.0565765	0.0555096	0.0544601	0.0534266	0.0524080	0.0514043	0.0504154	16
17	0.0532797	0.0522128	0.0511632	0.0501297	0.0491116	0.0481089	0.0471216	17
18	0.0498968	0.0488299	0.0477801	0.0467477	0.0457316	0.0447316	0.0437487	18
19	0.0468786	0.0458106	0.0447606	0.0437281	0.0427120	0.0417120	0.0407391	19
20	0.0442397	0.0431717	0.0421217	0.0410892	0.0400731	0.0390731	0.0380902	20
21	0.0419655	0.0408975	0.0398475	0.0388150	0.0378089	0.0368202	0.0358489	21
22	0.0398703	0.0388023	0.0377523	0.0367298	0.0357337	0.0347640	0.0338107	22
23	0.0379308	0.0368628	0.0358128	0.0347803	0.0337742	0.0327945	0.0318312	23
24	0.0361421	0.0350741	0.0340241	0.0329916	0.0319855	0.0309958	0.0300225	24
25	0.0344936	0.0334256	0.0323756	0.0313431	0.0303370	0.0293473	0.0283740	25
26	0.0329732	0.0319052	0.0308552	0.0298227	0.0288166	0.0278269	0.0268536	26
27	0.0315707	0.0305027	0.0294527	0.0284202	0.0274141	0.0264244	0.0254511	27
28	0.0292801	0.0282121	0.0271621	0.0261296	0.0251235	0.0241338	0.0231605	28
29	0.0271778	0.0261098	0.0250598	0.0240273	0.0230212	0.0220315	0.0210582	29
30	0.0252432	0.0241752	0.0231252	0.0220927	0.0210866	0.0200969	0.0191236	30
31	0.0234653	0.0223973	0.0213473	0.0203148	0.0193087	0.0183290	0.0173657	31
32	0.0218474	0.0207794	0.0197294	0.0187069	0.0177108	0.0167411	0.0157878	32
33	0.0203795	0.0193115	0.0182615	0.0172390	0.0162429	0.0152732	0.0143299	33
34	0.0190516	0.0179836	0.0169336	0.0159111	0.0149150	0.0139453	0.0129920	34
35	0.0178637	0.0167957	0.0157457	0.0147232	0.0137271	0.0127574	0.0118141	35
36	0.0168158	0.0157478	0.0146978	0.0136753	0.0126792	0.0117095	0.0107662	36
37	0.0159079	0.0148399	0.0137899	0.0127674	0.0117713	0.0108016	0.0098583	37
38	0.0151300	0.0140620	0.0130120	0.0119895	0.0109934	0.0100237	0.0090804	38
39	0.0144821	0.0134141	0.0123641	0.0113416	0.0103455	0.0093758	0.0084325	39
40	0.0139542	0.0128862	0.0118362	0.0108137	0.0098176	0.0088479	0.0079046	40
41	0.0135363	0.0124683	0.0114183	0.0103958	0.0093997	0.0084200	0.0074667	41
42	0.0132184	0.0121504	0.0111004	0.0100779	0.0090818	0.0081121	0.0071688	42
43	0.0129005	0.0118325	0.0107825	0.0097500	0.0087539	0.0077842	0.0068409	43
44	0.0125926	0.0115246	0.0104746	0.0094421	0.0084460	0.0074763	0.0065330	44
45	0.0122947	0.0112267	0.0101767	0.0091442	0.0081481	0.0071784	0.0062351	45
46	0.0120068	0.0109388	0.0098888	0.0088563	0.0078602	0.0068805	0.0059172	46
47	0.0117289	0.0106609	0.0096109	0.0085784	0.0075823	0.0066026	0.0056493	47
48	0.0114610	0.0103930	0.0093430	0.0083105	0.0073144	0.0063347	0.0053814	48
49	0.0112031	0.0101351	0.0090851	0.0080526	0.0070565	0.0060868	0.0051335	49
50	0.0109552	0.0098872	0.0088372	0.0078047	0.0068086	0.0058389	0.0048856	50
51	0.0107173	0.0096493	0.0085993	0.0075668	0.0065707	0.0056010	0.0046477	51
52	0.0104894	0.0094214	0.0083714	0.0073389	0.0063428	0.0053731	0.0044298	52
53	0.0102615	0.0091935	0.0081435	0.0071110	0.0061149	0.0051452	0.0041919	53
54	0.0100436	0.0089756	0.0079256	0.0068931	0.0058970	0.0049273	0.0039740	54
55	0.0098257	0.0087577	0.0077077	0.0066752	0.0056791	0.0047094	0.0037661	55
56	0.0096078	0.0085398	0.0074898	0.0064573	0.0054612	0.0044915	0.0035482	56
57	0.0093900	0.0083220	0.0072720	0.0062395	0.0052434	0.0042737	0.0033304	57
58	0.0091721	0.0081041	0.0070541	0.0060216	0.0050255	0.0040558	0.0031125	58
59	0.0089542	0.0078862	0.0068362	0.0058037	0.0048076	0.0038379	0.0028946	59
60	0.0087363	0.0076683	0.0066183	0.0055858	0.0045897	0.0036200	0.0026767	60

TABLE 33.—The annual sinking fund which will accumulate to 1 at the end of *n* years—Continued.

$$\frac{1}{sn} = \frac{i}{(1+i)^n - 1}$$

Years.	3½%.	4%.	4½%.	5%.	5½%.	6%.	7%.	Years.
1	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1
2	0.4914006	0.4801961	0.4898976	0.4878049	0.4861180	0.4854369	0.4830918	2
3	0.3219343	0.3203485	0.3177734	0.3172086	0.3158541	0.3141098	0.3110517	3
4	0.2372511	0.2354901	0.2337437	0.2320118	0.2302945	0.2285915	0.2252221	4
5	0.1864814	0.1846271	0.1829716	0.1809748	0.1791764	0.1773926	0.1738907	5
6	0.1526632	0.1507619	0.1488794	0.1470175	0.1451790	0.1433624	0.1397968	6
7	0.1285445	0.1266006	0.1247015	0.1228188	0.1209644	0.1191350	0.1155532	7
8	0.1104787	0.1085278	0.1066097	0.1047218	0.1028640	0.1010350	0.0974678	8
9	0.0984460	0.0964930	0.0945745	0.0926901	0.0908396	0.0890222	0.0853965	9
10	0.0882414	0.0862909	0.0843788	0.0825046	0.0806678	0.0788690	0.0752375	10
11	0.0796940	0.0777490	0.0758482	0.0739889	0.0721707	0.0703929	0.0668569	11
12	0.0726480	0.0707032	0.0688022	0.0669454	0.0651292	0.0633577	0.0599270	12
13	0.0668166	0.0648718	0.0629693	0.0611118	0.0592950	0.0575201	0.0541929	13
14	0.0620707	0.0601259	0.0582133	0.0563458	0.0545221	0.0527454	0.0494149	14
15	0.0582361	0.0562913	0.0543788	0.0525113	0.0506876	0.0489088	0.0455746	15
16	0.0551648	0.0532200	0.0513075	0.0494399	0.0476162	0.0458364	0.0425007	16
17	0.0527041	0.0507593	0.0488468	0.0469792	0.0451555	0.0433757	0.0400400	17
18	0.0507048	0.0487600	0.0468475	0.0449799	0.0431562	0.0413764	0.0380407	18
19	0.0490408	0.0470960	0.0451835	0.0433159	0.0414922	0.0397124	0.0363767	19
20	0.0476311	0.0456863	0.0437738	0.0419062	0.0400825	0.0383027	0.0349670	20
21	0.0463666	0.0444218	0.0425093	0.0406417	0.0388180	0.0370382	0.0337025	21
22	0.0452161	0.0432713	0.0413588	0.0394912	0.0376675	0.0358877	0.0325520	22
23	0.0441606	0.0422158	0.0403033	0.0384357	0.0366120	0.0348322	0.0314965	23
24	0.0431901	0.0412453	0.0393328	0.0374652	0.0356415	0.0338617	0.0305260	24
25	0.0423046	0.0403598	0.0384473	0.0365797	0.0347560	0.0329762	0.0296405	25
26	0.0414841	0.0395393	0.0376268	0.0357592	0.0339355	0.0321557	0.0288200	26
27	0.0407286	0.0387838	0.0368713	0.0350037	0.0331799	0.0313991	0.0280634	27
28	0.0400281	0.0380833	0.0361708	0.0343032	0.0324795	0.0306987	0.0273630	28
29	0.0393726	0.0374278	0.0355153	0.0336477	0.0318240	0.0299992	0.0266635	29
30	0.0387521	0.0368073	0.0348948	0.0330281	0.0312044	0.0293796	0.0260439	30
31	0.0381666	0.0362218	0.0343093	0.0324426	0.0306189	0.0287941	0.0254584	31
32	0.0376161	0.0356713	0.0337588	0.0318921	0.0300684	0.0282436	0.0249079	32
33	0.0370906	0.0351458	0.0332333	0.0313666	0.0295429	0.0277181	0.0243824	33
34	0.0365801	0.0346353	0.0327228	0.0308561	0.0290324	0.0272076	0.0238719	34
35	0.0360846	0.0341398	0.0322273	0.0303606	0.0285369	0.0267121	0.0233764	35
36	0.0356041	0.0336593	0.0317418	0.0298851	0.0280614	0.0262366	0.0229009	36
37	0.0351386	0.0331938	0.0312763	0.0294196	0.0275959	0.0257711	0.0224354	37
38	0.0346881	0.0327433	0.0308258	0.0289641	0.0271404	0.0253156	0.0219800	38
39	0.0342526	0.0323078	0.0303903	0.0285186	0.0266949	0.0248701	0.0215344	39
40	0.0338321	0.0318873	0.0300008	0.0280831	0.0262594	0.0244346	0.0211000	40
41	0.0334266	0.0314818	0.0295953	0.0276576	0.0258339	0.0240091	0.0206734	41
42	0.0330361	0.0310923	0.0292058	0.0272321	0.0254084	0.0235836	0.0202479	42
43	0.0326606	0.0307178	0.0288263	0.0268166	0.0249919	0.0231671	0.0198314	43
44	0.0322901	0.0303473	0.0284558	0.0264061	0.0245814	0.0227566	0.0194209	44
45	0.0319346	0.0300018	0.0281003	0.0260056	0.0241809	0.0223561	0.0190454	45
46	0.0315841	0.0296620	0.0277598	0.0256151	0.0237904	0.0219656	0.0186750	46
47	0.0312486	0.0293365	0.0274343	0.0252406	0.0234159	0.0215911	0.0183003	47
48	0.0309281	0.0290210	0.0271188	0.0248761	0.0230514	0.0212266	0.0179696	48
49	0.0306226	0.0287155	0.0268133	0.0245216	0.0227069	0.0208821	0.0176439	49
50	0.0303321	0.0284190	0.0265228	0.0241771	0.0223624	0.0205376	0.0173492	50
51	0.0300566	0.0281325	0.0262423	0.0238426	0.0220379	0.0202131	0.0170745	51
52	0.0297961	0.0278560	0.0259718	0.0235181	0.0217134	0.0198886	0.0168159	52
53	0.0295506	0.0275905	0.0257063	0.0232036	0.0214089	0.0195841	0.0165604	53
54	0.0293201	0.0273350	0.0254358	0.0228991	0.0211042	0.0192794	0.0163149	54
55	0.0291046	0.0270895	0.0251753	0.0226046	0.0208197	0.0189949	0.0160794	55
56	0.0289041	0.0268540	0.0249248	0.0223201	0.0205352	0.0187104	0.0158539	56
57	0.0287186	0.0266285	0.0246643	0.0220456	0.0202607	0.0184359	0.0156184	57
58	0.0285481	0.0264130	0.0244138	0.0217811	0.0200002	0.0181814	0.0153929	58
59	0.0283926	0.0262075	0.0241733	0.0215266	0.0197507	0.0179369	0.0151774	59
60	0.0282521	0.0260120	0.0239428	0.0212821	0.0195112	0.0176974	0.0149729	60

TABLE 34.—The present value of 1 due in n years.

$$v^n = (1+i)^{-n}$$

Years.	1½%.	1%.	5%.	3½%.	3%.	2½%.	2%.	Years.
1	0.9852217	0.9828010	0.9808823	0.9779851	0.9758098	0.9733260	0.9705728	1
2	0.9705618	0.9685978	0.9651688	0.9604744	0.9571814	0.9537883	0.9492959	2
3	0.9559170	0.9529253	0.9482223	0.9424273	0.9385994	0.9345878	0.9304117	3
4	0.9421842	0.9386885	0.9338454	0.9278123	0.9235906	0.9197157	0.9161671	4
5	0.9282903	0.9242126	0.9189708	0.9126191	0.9088643	0.9051540	0.9014888	5
6	0.9145422	0.9091428	0.9029714	0.8950243	0.8892369	0.8837849	0.8786453	6
7	0.9010268	0.8952632	0.8885602	0.8809395	0.8746262	0.8685044	0.8625615	7
8	0.8877111	0.8815116	0.8743904	0.8663884	0.8602746	0.8543539	0.8486128	8
9	0.8745822	0.8679414	0.8603753	0.8519216	0.8457284	0.8396939	0.8338167	9
10	0.8616672	0.8545286	0.8465101	0.8376193	0.8311984	0.8249379	0.8188399	10
11	0.8489832	0.8413689	0.8329630	0.8236850	0.8172148	0.8109631	0.8049213	11
12	0.8365874	0.8285793	0.8198030	0.8099878	0.8033559	0.7969041	0.7906279	12
13	0.8244270	0.8159213	0.8067325	0.7965191	0.7895204	0.7827372	0.7761553	13
14	0.8124842	0.8035489	0.7939750	0.7833414	0.7762722	0.7693673	0.7626118	14
15	0.7998515	0.7904746	0.7804147	0.7692863	0.7618456	0.7545808	0.7474860	15
16	0.7880810	0.7782613	0.7678458	0.7564653	0.7486249	0.7409242	0.7333634	16
17	0.7769863	0.7667281	0.7558626	0.7440821	0.7358191	0.7276634	0.7196165	17
18	0.7665916	0.7558916	0.7446159	0.7324776	0.7238559	0.7152509	0.7067634	18
19	0.7568075	0.7456649	0.7339308	0.7213485	0.7122724	0.7032139	0.6942739	19
20	0.7476204	0.7360246	0.7238465	0.7108165	0.7012709	0.6917306	0.6822958	20
21	0.7389480	0.7268679	0.7142758	0.6997154	0.6896368	0.6795590	0.6695823	21
22	0.7306876	0.7182203	0.7052390	0.6902246	0.6806672	0.6705994	0.6606316	22
23	0.7227371	0.7100071	0.6965959	0.6812359	0.6712782	0.6611204	0.6510626	23
24	0.7150943	0.7020043	0.6883030	0.6725030	0.6621453	0.6517875	0.6415297	24
25	0.7077624	0.6943224	0.6802711	0.6641211	0.6534634	0.6429056	0.6324478	25
26	0.7007305	0.6869405	0.6725292	0.6559292	0.6448715	0.6343137	0.6238559	26
27	0.6939986	0.6798486	0.6651773	0.6481273	0.6366696	0.6256118	0.6147540	27
28	0.6875667	0.6730567	0.6580454	0.6406254	0.6287677	0.6177099	0.6068521	28
29	0.6814348	0.6665848	0.6512735	0.6334935	0.6212358	0.6100780	0.5990202	29
30	0.6756029	0.6604129	0.6448016	0.6266816	0.6141239	0.6025661	0.5911083	30
31	0.6700710	0.6545210	0.6385797	0.6199997	0.6070420	0.5951842	0.5834264	31
32	0.6648391	0.6489491	0.6326678	0.6137278	0.6003701	0.5881123	0.5760545	32
33	0.6599072	0.6437672	0.6271459	0.6078459	0.5941882	0.5815304	0.5690726	33
34	0.6552753	0.6388853	0.6217240	0.6021640	0.5881063	0.5750485	0.5622907	34
35	0.6509434	0.6343034	0.6168021	0.5969821	0.5825244	0.5691666	0.5560088	35
36	0.6468115	0.6298215	0.6120002	0.5918202	0.5769625	0.5632047	0.5496469	36
37	0.6428796	0.6255496	0.6074383	0.5869183	0.5716606	0.5575028	0.5436450	37
38	0.6391477	0.6214577	0.6030064	0.5821464	0.5665887	0.5521309	0.5379731	38
39	0.6356158	0.6175658	0.5991545	0.5779545	0.5620968	0.5473390	0.5328812	39
40	0.6322839	0.6139739	0.5952626	0.5737226	0.5575649	0.5425071	0.5277493	40
41	0.6291520	0.6105920	0.5916207	0.5700207	0.5535630	0.5381052	0.5230474	41
42	0.6262201	0.6074101	0.5881788	0.5662288	0.5494711	0.5336133	0.5180555	42
43	0.6234882	0.6044182	0.5850069	0.5637069	0.5465492	0.5302914	0.5145336	43
44	0.6209563	0.6016263	0.5823750	0.5610250	0.5435673	0.5269095	0.5111517	44
45	0.6186244	0.5990344	0.5800031	0.5590031	0.5412454	0.5242876	0.5083298	45
46	0.6164925	0.5966425	0.5778712	0.5565712	0.5385135	0.5212557	0.5052979	46
47	0.6145606	0.5944106	0.5759399	0.5544399	0.5360822	0.5185244	0.5025666	47
48	0.6128287	0.5924787	0.5742080	0.5524080	0.5337503	0.5158925	0.5000347	48
49	0.6112968	0.5907468	0.5726761	0.5506761	0.5317184	0.5135606	0.4977028	49
50	0.6099649	0.5892149	0.5712442	0.5493442	0.5300807	0.5116229	0.4957651	50
51	0.6088330	0.5878830	0.5700031	0.5482131	0.5285496	0.5100018	0.4941440	51
52	0.6078911	0.5867211	0.5689320	0.5472420	0.5272881	0.5084503	0.4925925	52
53	0.6071292	0.5857292	0.5680009	0.5464109	0.5262170	0.5071792	0.4913207	53
54	0.6065373	0.5848973	0.5672698	0.5457198	0.5253459	0.5061481	0.4903622	54
55	0.6061054	0.5842254	0.5667087	0.5452287	0.5248548	0.5056570	0.4898705	55
56	0.6058235	0.5838035	0.5663868	0.5449068	0.5246329	0.5054351	0.4896486	56
57	0.6056516	0.5836316	0.5662649	0.5448249	0.5245510	0.5053532	0.4895667	57
58	0.6055797	0.5835597	0.5662130	0.5447730	0.5245091	0.5053113	0.4895248	58
59	0.6055278	0.5835078	0.5661711	0.5447311	0.5244672	0.5052694	0.4894829	59
60	0.6054859	0.5834659	0.5661392	0.5446892	0.5244253	0.5052275	0.4894410	60

TABLE 34.—The present value of 1 due in n years—Continued.

$$v^n = (1+i)^{-n}$$

Years.	2½%.	4%.	4½%.	5%.	5½%.	6%.	7%.	Years.
1	0.9661836	0.9615385	0.9569378	0.9523810	0.9478673	0.9433962	0.9389794	1
2	0.9335107	0.9245562	0.9157300	0.9070295	0.8984524	0.8899964	0.8816587	2
3	0.9019427	0.8899964	0.8762066	0.8688876	0.8616137	0.8544198	0.8472970	3
4	0.8714423	0.8548042	0.8385613	0.8227025	0.8072167	0.7920937	0.7762862	4
5	0.8419722	0.8219271	0.8024511	0.7835262	0.7651244	0.7472582	0.7299862	5
6	0.8135006	0.7908145	0.7678967	0.7463164	0.7252458	0.7046905	0.6846422	6
7	0.7859910	0.7599178	0.7348285	0.7106813	0.6874368	0.6650571	0.6427497	7
8	0.7594116	0.7306802	0.7031851	0.6768394	0.6515989	0.6274124	0.6032001	8
9	0.7337310	0.7023867	0.6729044	0.6446089	0.6176293	0.5918985	0.5673937	9
10	0.7089188	0.6755642	0.6439277	0.6139123	0.5854806	0.5583948	0.5325493	10
11	0.6849457	0.6495909	0.6161987	0.5846793	0.5549105	0.5267875	0.4999026	11
12	0.6617833	0.6245971	0.5896639	0.5588374	0.5296815	0.4999094	0.4727497	12
13	0.6394942	0.6005741	0.5642716	0.5308214	0.4985607	0.4683900	0.4404454	13
14	0.6177818	0.5774751	0.5399729	0.5050680	0.4725694	0.4423010	0.4138172	14
15	0.5968906	0.5552645	0.5167204	0.4810171	0.4479331	0.4172651	0.3882460	15
16	0.5767059	0.5339082	0.4944968	0.4581115	0.4245811	0.3936463	0.3643746	16
17	0.5572088	0.5133733	0.4731764	0.4362967	0.4024465	0.3713644	0.3427497	17
18	0.5383611	0.4936281	0.4528004	0.4155207	0.3814659	0.3500438	0.3216939	18
19	0.5201587	0.4746424	0.4333018	0.3957840	0.3615791	0.3306130	0.3025083	19
20	0.5025659	0.4563870	0.4146429	0.3768995	0.3427290	0.3115947	0.2828190	20
21	0.4855709	0.4388336	0.3967874	0.3589424	0.3248616	0.2941554	0.2651531	21
22	0.4691506	0.4219554	0.3797009	0.3418499	0.3079287	0.2775051	0.2487122	22
23	0.4532856	0.4057268	0.3633501	0.3255713	0.2916727	0.2617973	0.2334969	23
24	0.4379571	0.3901216	0.3477085	0.3100679	0.2761566	0.2467986	0.2191466	24
25	0.4231470	0.3751168	0.3323706	0.2953028	0.2623387	0.2329986	0.2058492	25
26	0.4088377	0.3606892	0.3184026	0.2812407	0.2485628	0.2198100	0.1921955	26
27	0.3950122	0.3465196	0.3046914	0.2678483	0.2356045	0.2073980	0.1803904	27
28	0.3816543	0.3324775	0.2915707	0.2550986	0.2233218	0.1956901	0.1694022	28
29	0.3687432	0.3206514	0.2790150	0.2429463	0.2116794	0.1845567	0.1586628	29
30	0.3562794	0.3083187	0.2670000	0.2318775	0.2006440	0.1741101	0.1485671	30
31	0.3442804	0.2964608	0.2555024	0.2203595	0.1901839	0.1642548	0.1387730	31
32	0.3326897	0.2850579	0.2444999	0.2098662	0.1802691	0.1549574	0.1294711	32
33	0.3213437	0.2740942	0.2339712	0.1998726	0.1708712	0.1461962	0.1207247	33
34	0.3104761	0.2635521	0.2239859	0.1903543	0.1619632	0.1379115	0.1125013	34
35	0.2999799	0.2534155	0.2142544	0.1812903	0.1535196	0.1291052	0.1039639	35
36	0.2898327	0.2436687	0.2050282	0.1726574	0.1455162	0.1227408	0.0975355	36
37	0.2800816	0.2342969	0.1961992	0.1644356	0.1379801	0.1157932	0.0918098	37
38	0.2706619	0.2252854	0.1877504	0.1566054	0.1307394	0.1092389	0.0864569	38
39	0.2614125	0.2166200	0.1796655	0.1491490	0.1239236	0.1030655	0.0794550	39
40	0.2525725	0.2083890	0.1719287	0.1420457	0.1174631	0.0972222	0.0747804	40
41	0.2440814	0.2002779	0.1646261	0.1352816	0.1113395	0.0917191	0.0692416	41
42	0.2357791	0.1925749	0.1574408	0.1288396	0.1053350	0.0865274	0.0653286	42
43	0.2276059	0.1851682	0.1506605	0.1227044	0.1000832	0.0816296	0.0614127	43
44	0.2201023	0.1780464	0.1441728	0.1168613	0.0948132	0.0770091	0.0580464	44
45	0.2126592	0.1711984	0.1379644	0.1112965	0.0896751	0.0726501	0.0547613	45
46	0.2054679	0.1646130	0.1320223	0.1059967	0.0851897	0.0685378	0.0444986	46
47	0.1986197	0.1582826	0.1263381	0.1009492	0.0807435	0.0646583	0.0415875	47
48	0.1921865	0.1521948	0.1208977	0.0961421	0.0765399	0.0609964	0.0388668	48
49	0.1861302	0.1463411	0.1156916	0.0915639	0.0725437	0.0575457	0.0363241	49
50	0.1799534	0.1407126	0.1107097	0.0872037	0.0687665	0.0542884	0.0340478	50
51	0.1739984	0.1353006	0.1059428	0.0830512	0.0651815	0.0512154	0.0317290	51
52	0.1671482	0.1300967	0.1013801	0.0790964	0.0617834	0.0483165	0.0296513	52
53	0.1614950	0.1250930	0.0970145	0.0753299	0.0585625	0.0455816	0.0277115	53
54	0.1560387	0.1202817	0.0928368	0.0717427	0.0555095	0.0430015	0.0258986	54
55	0.1507581	0.1156555	0.0888391	0.0683264	0.0526156	0.0405674	0.0242043	55
56	0.1456600	0.1112072	0.0850135	0.0650726	0.0498726	0.0381712	0.0226206	56
57	0.1407373	0.1069390	0.0813526	0.0619741	0.0472728	0.0361049	0.0211410	57
58	0.1359752	0.1028173	0.0778494	0.0590239	0.0448082	0.0340812	0.0197579	58
59	0.1313770	0.0988328	0.0744970	0.0562128	0.0424722	0.0321332	0.0184653	59
60	0.1269343	0.0950904	0.0712890	0.0535355	0.0402580	0.0303143	0.0172578	60

TABLE 35.—The present value of an annuity of 1 for n years.

$$a_n = \frac{1-v^n}{i}$$

Years.	1½%.	1½%.	2%.	2½%.	3%.	3½%.	4%.	Years.
1	0.9832217	0.9828010	0.9808823	0.9778861	0.9750086	0.9722360	0.9705728	1
2	1.9655894	1.9650088	1.9616609	1.9564698	1.9512422	1.9460363	1.9412497	2
3	2.9122004	2.9079940	2.8928933	2.8769949	2.8602286	2.8426221	2.8251114	3
4	3.8643547	3.8506435	3.8077287	3.7847402	3.7619743	3.7394279	3.7170864	4
5	4.7826480	4.7478551	4.7134585	4.6794525	4.6458285	4.6125619	4.5796702	5
6	5.6971872	5.6489976	5.6014309	5.5544708	5.5081284	5.4623988	5.4171914	6
7	6.5983140	6.5365414	6.4759911	6.4162463	6.3580906	6.2994081	6.2402880	7
8	7.4869251	7.4086830	7.3264814	7.2471848	7.1701872	7.0943144	7.0195622	8
9	8.3651478	8.2694643	8.1632867	8.0567083	7.9705555	7.8776783	7.7870599	9
10	9.2331846	9.1123229	8.9836850	8.8632164	8.7390639	8.6400762	8.5802028	10
11	10.0711178	9.9274918	9.7899481	9.6491112	9.5142057	9.3830068	9.2626241	11
12	10.9076063	10.7385497	10.5738413	10.4147786	10.2677646	10.1243387	9.9840040	12
13	11.7315322	11.5376410	11.3483788	11.1636979	10.9831280	10.8070109	10.6346553	13
14	12.5433615	12.3230059	12.1033488	11.8853382	11.6690123	11.4910061	11.2907781	14
15	13.3432330	13.0928905	12.8426385	12.6121654	12.3813777	12.1509899	11.9879651	15
16	14.1312641	13.8504968	13.5777063	13.3126313	13.0550027	12.8045723	12.5611020	16
17	14.9076493	14.5965628	14.2915719	13.9976894	13.7121977	13.4343999	13.1631183	17
18	15.6726009	15.3208637	14.9620313	14.6676611	14.3833636	14.0487066	13.7335131	18
19	16.4261694	16.0406067	15.6784630	15.3228660	14.9789018	14.6430016	14.3267991	19
20	17.1683888	16.7523813	16.3514333	15.9687124	15.5981633	15.2272621	14.8774749	20
21	17.9001267	17.4475492	17.0113082	16.5904378	16.1845438	15.7939461	15.4182241	21
22	18.6076044	18.1302644	17.6580483	17.2083523	16.7984192	16.4034999	16.0269106	22
23	19.3006615	18.8013476	18.3023041	17.8027895	17.3321105	16.8768186	16.4438094	23
24	20.0804054	19.4906057	18.9182256	18.3860862	17.8949658	17.4007667	16.9855421	24
25	20.7196112	20.1067920	19.5294565	18.9633826	18.4243764	17.9083180	17.4131477	25
26	21.3966817	20.7467817	20.1210858	19.5231126	18.9606111	18.4022559	17.8769424	26
27	22.0676176	21.3717264	20.7089978	20.0715038	19.4640109	18.8829741	18.3270315	27
28	22.7367167	21.9896847	21.2812724	20.6078276	19.9648887	19.3506264	18.7641062	28
29	23.3977056	22.5910171	21.8433847	21.1323498	20.4535495	19.8081571	19.1894546	29
30	24.0168380	23.1859498	22.3964556	21.6453290	20.9302926	20.2493013	19.6004414	30
31	24.6461458	23.7696765	22.9577015	22.1470219	21.3965470	20.6905883	20.0004285	31
32	25.2671387	24.3438690	23.4683248	22.6376742	21.8491780	21.1008263	20.3897655	32
33	25.8789644	24.9079696	23.9685636	23.1173298	22.2918909	21.5008933	20.7687918	33
34	26.4814285	25.4632779	24.4985917	23.5868262	22.7237963	21.9064077	21.1318367	34
35	27.0756646	26.0072510	24.9986198	24.0457968	23.1451578	22.2933403	21.4872201	35
36	27.6606848	26.5427028	25.4988425	24.4946658	23.5562511	22.6699175	21.8322625	36
37	28.2371274	27.0690446	25.9994534	24.9336585	23.9573181	23.034161	22.1672354	37
38	28.8050516	27.5862846	26.4406406	25.3639012	24.3466280	23.3981057	22.4909616	38
39	29.3645320	28.0946286	26.9025888	25.7837765	24.7399444	23.7402488	22.8062151	39
40	29.9158453	28.5942296	27.3554792	26.1986222	25.1027761	24.0781011	23.1147720	40
41	30.4599608	29.0852879	27.7994895	26.5961217	25.4661220	24.4096110	23.4194000	41
42	30.9940500	29.5678014	28.2347896	26.9870030	25.8200068	24.7262207	23.7018562	42
43	31.5212816	30.0420562	28.6615623	27.3720832	26.1664457	25.0386356	23.9819021	43
44	32.0402222	30.5051732	29.0796631	27.7477067	26.5068495	25.3414751	24.2542739	44
45	32.5522872	30.9669236	29.4901599	28.1151195	26.8390229	25.6364721	24.5187126	45
46	33.0564898	31.4164748	29.8923136	28.4744445	27.1541696	25.9288738	24.7764491	46
47	33.5531920	31.8599428	30.2855820	28.8268626	27.4674526	26.2092915	25.0247078	47
48	34.0425537	32.2969012	30.6731196	29.1696478	27.7731537	26.4749809	25.2667068	48
49	34.5246534	32.7211806	31.0530780	29.5056702	28.0713995	26.7399923	25.5010569	49
50	34.9996851	33.1412096	31.4239069	29.8349603	28.3623117	26.9971700	25.7297640	50
51	35.4676780	33.5540142	31.7878489	30.1558898	28.6461577	27.2478540	25.9512372	51
52	35.9287419	33.9597191	32.1449499	30.4708039	28.9230907	27.4918267	26.1662400	52
53	36.3829609	34.3584468	32.4950489	30.7778062	29.1932487	27.7270787	26.3749903	53
54	36.8303389	34.7506158	32.8388268	31.0765991	29.4566268	27.9539932	26.5770006	54
55	37.2714068	35.1364468	33.1747875	31.3720544	29.7139793	28.1836968	26.7744276	55
56	37.7056786	35.5139514	33.5046937	31.6602977	29.9648578	28.4041545	26.9654687	56
57	38.1339708	35.8839478	33.8281810	31.9416114	30.2096174	28.6171820	27.1509357	57
58	38.5565875	36.2461542	34.1452265	32.2167349	30.4484072	28.8234591	27.3310066	58
59	38.9730729	36.6010658	34.4561044	32.4868048	30.6813729	29.0236263	27.5066908	59
60	39.3830289	36.9693655	34.7606867	32.7496930	30.9085665	29.2230920	27.6786687	60

TABLE 35.—The present value of an annuity of 1 for n years—Continued.

$$a_n = \frac{1-v^n}{i}$$

Years.	3½%.	4%.	4½%.	5%.	5½%.	6%.	7%.	Years.
1	0.9661336	0.9615385	0.9569378	0.9523310	0.9477267	0.9431242	0.9385294	1
2	1.8696943	1.8560047	1.8423698	1.8287810	1.8152387	1.8017427	1.7882922	2
3	2.8016370	2.7750910	2.7486644	2.7223480	2.6961426	2.6700482	2.6440658	3
4	3.6730792	3.6296062	3.5872857	3.5451150	3.5030940	3.4612236	3.4195038	4
5	4.5150624	4.4518223	4.3897707	4.3289477	4.2702645	4.2128238	4.1566274	5
6	5.3265330	5.2421969	5.1578725	5.0735603	4.9892506	4.9172243	4.7666397	6
7	6.1145440	6.0020547	5.8927009	5.7833871	5.6820971	5.5828214	5.3822204	7
8	6.8796555	6.7327449	6.5865861	6.4432125	6.2945460	6.2067088	5.9711263	8
9	7.6078965	7.4353316	7.2687905	7.1078217	6.9521963	6.8016222	6.5132323	9
10	8.3160053	8.1109958	7.9127182	7.7217849	7.5379258	7.3600671	7.0285816	10
11	9.0015510	8.7604787	8.5299169	8.3064142	8.0895368	7.8897748	7.4966744	11
12	9.6638443	9.3850738	9.1185808	8.8632516	8.6185179	8.3848430	7.9426863	12
13	10.3027385	9.9854779	9.6828524	9.3935780	9.1170785	8.8524680	8.3576508	13
14	10.9205203	10.5631229	10.2222258	9.8964409	9.5894479	9.2946838	8.7444680	14
15	11.5174109	11.1183874	10.7364457	10.3796589	10.0479509	9.7192490	9.1079140	15
16	12.0941168	11.6522985	11.2340151	10.8377696	10.4921620	10.1608958	9.4466486	16
17	12.6513206	12.1654659	11.7071914	11.2740063	10.9040386	10.5477267	9.7682230	17
18	13.1894817	12.6592070	12.1669918	11.6965668	11.2460745	10.8570395	10.0506069	18
19	13.7083574	13.1333394	12.5982886	12.0953209	11.6076885	11.1811106	10.3365953	19
20	14.2124093	13.5933283	13.0079866	12.4622108	11.9608825	11.4969212	10.5940143	20
21	14.6979742	14.0291600	13.4047239	12.8211527	12.2783441	11.7640766	10.8365273	21
22	15.1671245	14.4511183	13.7842448	13.1680026	12.5831067	12.0415817	11.0612405	22
23	15.6204105	14.8584117	14.1477749	13.4985739	12.8704224	12.3037990	11.2721574	23
24	16.0589976	15.2466081	14.4964784	13.7986418	13.1516990	12.5508762	11.4688240	24
25	16.4851546	15.6230799	14.8238090	14.0699446	13.4196827	12.7886302	11.6486522	25
26	16.8993823	15.9827692	15.1406115	14.3751853	13.6624984	13.0081662	11.8257787	26
27	17.3025945	16.3265845	15.4518028	14.6430336	13.8909999	13.2103341	11.9907091	27
28	17.6950189	16.6560382	15.7428735	14.8951273	14.1214217	13.4061648	12.1571118	28
29	18.0767070	16.9637146	16.0218836	15.1410796	14.3381012	13.5907210	12.3176741	29
30	18.4484544	17.2500893	16.2868985	15.3794610	14.5387482	13.7639399	12.4690412	30
31	18.7992758	17.5189426	16.5448910	15.6028105	14.7239291	13.9200980	12.6118142	31
32	19.1306955	17.7735615	16.7889809	15.8026707	14.9041993	14.0640434	12.7465553	32
33	19.4450282	18.0164587	17.0226621	16.0026492	15.0786994	14.2022296	12.8757900	33
34	19.7436642	18.2411978	17.2467890	16.1929040	15.2370236	14.3351411	12.9940094	34
35	20.0266111	18.4506132	17.4610124	16.3741943	15.3906523	14.4639454	13.1047723	35
36	20.2940988	18.6462820	17.6660406	16.5468517	15.5390694	14.6200871	13.2082078	36
37	20.5465254	18.8287585	17.8522596	16.7112873	15.6739665	14.7397808	13.3170166	37
38	20.78410674	19.0078642	18.0499002	16.8678027	15.8047379	14.8460192	13.4247786	38
39	21.0094999	19.1844843	18.2299857	17.0170407	15.9229515	14.9490747	13.5266285	39
40	21.22560723	19.3572739	18.4015844	17.1590864	16.0461247	15.0463999	13.6217099	40
41	21.43301037	19.5269618	18.5661066	17.2949680	16.1574642	15.1380159	13.7041204	41
42	21.63184828	20.1862367	18.7235498	17.4232078	16.2629902	15.2245433	13.7842440	42
43	21.82269887	20.3707949	18.8742103	17.5459120	16.3630324	15.3061729	13.8608617	43
44	22.00797910	20.5489413	19.0183831	17.6627738	16.4578506	15.3831320	13.9379081	44
45	22.1784503	20.7200893	19.1563474	17.7740698	16.5477287	15.4569321	14.0068216	45
46	22.3340181	20.8846636	19.2883707	17.8800665	16.6326154	15.5243999	14.0690202	46
47	22.4849478	21.0430861	19.4147093	17.9810157	16.7136689	15.5902282	14.1301777	47
48	22.6302443	21.1951809	19.5364066	18.0771578	16.7902027	15.6502266	14.1847444	48
49	22.7706445	21.3414720	19.6512961	18.1687121	16.8627514	15.7077723	14.2379965	49
50	22.9061779	21.4821846	19.7600788	18.2568265	16.9315179	15.7619806	14.3007463	50
51	23.0365163	21.6174832	19.8679600	18.3397766	16.9969394	15.8130761	14.3247732	51
52	23.1617645	21.7475819	19.9668302	18.4180780	17.0584929	15.8613925	14.3621245	52
53	23.2827204	21.8726749	20.0583447	18.4924028	17.1170454	15.9069741	14.3989359	53
54	23.4123261	21.9929867	20.1591815	18.5631456	17.1726549	15.9509755	14.5127345	54
55	23.5404632	22.1085123	20.2480806	18.6344720	17.2261706	15.9935430	14.5969388	55
56	23.6671132	22.2195194	20.3330940	18.6984447	17.2780451	16.0348141	14.6625596	56
57	23.7924476	22.3267404	20.4143966	18.7608188	17.3283158	16.0649190	14.6937006	57
58	23.9165223	22.4306658	20.4922390	18.8196417	17.3671239	16.0939802	14.7094555	58
59	24.0377698	22.5329426	20.5697390	18.8757540	17.4036661	16.1211124	14.7226238	59
60	24.1447841	22.6234900	20.6380220	18.9292866	17.4498543	16.1461277	14.7691812	60

TABLE 36.—The annuity for n years which 1 will buy or the annuity needed to discharge a debt of 1 in n years with interest.

$$\frac{1}{a_n} = \frac{i}{1 - \sigma^n}$$

Years.	1½%.	1¾%.	2%.	2½%.	3%.	3½%.	4%.	Years.
1	1.0150000	1.0175000	1.0200000	1.0225000	1.0250000	1.0275000	1.0300000	1
2	0.5112779	0.5134630	0.5156406	0.5178176	0.5199922	0.5221653	0.5243368	2
3	0.3483330	0.3498675	0.3514047	0.3529446	0.3544872	0.3560324	0.3575804	3
4	0.2594448	0.2606894	0.2619368	0.2631869	0.2644397	0.2656952	0.2669534	4
5	0.2080898	0.2090214	0.2100584	0.2110902	0.2121268	0.2131682	0.2142144	5
6	0.1755252	0.1762226	0.1769258	0.1776246	0.1783288	0.1790334	0.1797384	6
7	0.1515552	0.1520006	0.1524460	0.1528914	0.1533368	0.1537822	0.1542276	7
8	0.1325640	0.1328429	0.1331218	0.1334007	0.1336796	0.1339585	0.1342374	8
9	0.1198008	0.1200581	0.1203154	0.1205727	0.1208300	0.1210873	0.1213446	9
10	0.1084342	0.1086754	0.1089166	0.1091578	0.1093990	0.1096402	0.1098814	10
11	0.0992328	0.0994704	0.0997080	0.0999456	0.1001832	0.1004208	0.1006584	11
12	0.0916800	0.0918126	0.0919452	0.0920778	0.0922104	0.0923430	0.0924756	12
13	0.0853404	0.0854728	0.0856052	0.0857376	0.0858700	0.0860024	0.0861348	13
14	0.0797223	0.0798496	0.0799769	0.0801042	0.0802315	0.0803588	0.0804861	14
15	0.0749444	0.0750667	0.0751890	0.0753113	0.0754336	0.0755559	0.0756782	15
16	0.0707651	0.0708824	0.0709997	0.0711170	0.0712343	0.0713516	0.0714689	16
17	0.0670797	0.0671920	0.0673043	0.0674166	0.0675289	0.0676412	0.0677535	17
18	0.0638058	0.0639131	0.0640204	0.0641277	0.0642350	0.0643423	0.0644496	18
19	0.0608735	0.0609758	0.0610781	0.0611804	0.0612827	0.0613850	0.0614873	19
20	0.0582457	0.0583420	0.0584383	0.0585346	0.0586309	0.0587272	0.0588235	20
21	0.0558955	0.0559858	0.0560761	0.0561664	0.0562567	0.0563470	0.0564373	21
22	0.0537033	0.0537886	0.0538739	0.0539592	0.0540445	0.0541298	0.0542151	22
23	0.0517308	0.0518111	0.0518914	0.0519717	0.0520520	0.0521323	0.0522126	23
24	0.0499241	0.0499994	0.0500747	0.0501500	0.0502253	0.0503006	0.0503759	24
25	0.0482635	0.0483338	0.0484041	0.0484744	0.0485447	0.0486150	0.0486853	25
26	0.0467320	0.0467973	0.0468626	0.0469279	0.0469932	0.0470585	0.0471238	26
27	0.0453158	0.0453761	0.0454364	0.0454967	0.0455570	0.0456173	0.0456776	27
28	0.0440011	0.0440564	0.0441117	0.0441670	0.0442223	0.0442776	0.0443329	28
29	0.0427738	0.0428251	0.0428764	0.0429277	0.0429790	0.0430303	0.0430816	29
30	0.0416392	0.0416865	0.0417338	0.0417811	0.0418284	0.0418757	0.0419230	30
31	0.0405843	0.0406266	0.0406689	0.0407112	0.0407535	0.0407958	0.0408381	31
32	0.0396071	0.0396444	0.0396817	0.0397190	0.0397563	0.0397936	0.0398309	32
33	0.0387044	0.0387367	0.0387690	0.0388013	0.0388336	0.0388659	0.0388982	33
34	0.0378761	0.0379034	0.0379307	0.0379580	0.0379853	0.0380126	0.0380399	34
35	0.0370936	0.0371159	0.0371382	0.0371605	0.0371828	0.0372051	0.0372274	35
36	0.0363524	0.0363697	0.0363870	0.0364043	0.0364216	0.0364389	0.0364562	36
37	0.0356414	0.0356537	0.0356660	0.0356783	0.0356906	0.0357029	0.0357152	37
38	0.0349471	0.0349554	0.0349637	0.0349720	0.0349803	0.0349886	0.0349969	38
39	0.0342654	0.0342697	0.0342740	0.0342783	0.0342826	0.0342869	0.0342912	39
40	0.0335927	0.0335930	0.0335933	0.0335936	0.0335939	0.0335942	0.0335945	40
41	0.0329311	0.0329314	0.0329317	0.0329320	0.0329323	0.0329326	0.0329329	41
42	0.0322843	0.0322846	0.0322849	0.0322852	0.0322855	0.0322858	0.0322861	42
43	0.0316477	0.0316480	0.0316483	0.0316486	0.0316489	0.0316492	0.0316495	43
44	0.0310174	0.0310177	0.0310180	0.0310183	0.0310186	0.0310189	0.0310192	44
45	0.0303921	0.0303924	0.0303927	0.0303930	0.0303933	0.0303936	0.0303939	45
46	0.0297718	0.0297721	0.0297724	0.0297727	0.0297730	0.0297733	0.0297736	46
47	0.0291565	0.0291568	0.0291571	0.0291574	0.0291577	0.0291580	0.0291583	47
48	0.0285462	0.0285465	0.0285468	0.0285471	0.0285474	0.0285477	0.0285480	48
49	0.0279409	0.0279412	0.0279415	0.0279418	0.0279421	0.0279424	0.0279427	49
50	0.0273406	0.0273409	0.0273412	0.0273415	0.0273418	0.0273421	0.0273424	50
51	0.0267453	0.0267456	0.0267459	0.0267462	0.0267465	0.0267468	0.0267471	51
52	0.0261550	0.0261553	0.0261556	0.0261559	0.0261562	0.0261565	0.0261568	52
53	0.0255697	0.0255699	0.0255702	0.0255705	0.0255708	0.0255711	0.0255714	53
54	0.0249894	0.0249896	0.0249899	0.0249902	0.0249905	0.0249908	0.0249911	54
55	0.0244141	0.0244143	0.0244146	0.0244149	0.0244152	0.0244155	0.0244158	55
56	0.0238438	0.0238440	0.0238443	0.0238446	0.0238449	0.0238452	0.0238455	56
57	0.0232785	0.0232787	0.0232790	0.0232793	0.0232796	0.0232799	0.0232802	57
58	0.0227182	0.0227184	0.0227187	0.0227190	0.0227193	0.0227196	0.0227199	58
59	0.0221629	0.0221631	0.0221634	0.0221637	0.0221640	0.0221643	0.0221646	59
60	0.0216126	0.0216128	0.0216131	0.0216134	0.0216137	0.0216140	0.0216143	60

TABLE 36.—The annuity for n years which 1 will buy or the annuity needed to discharge a debt of 1 in n years with interest—Continued.

$$\frac{1}{a_{\overline{n}|i}} = \frac{i}{1-v^n}$$

Years.	3½%.	4%.	4½%.	5%.	5½%.	6%.	7%.	Years.
1	1.0350000	1.0400000	1.0450000	1.0500000	1.0550000	1.0600000	1.0700000	1
2	0.5264006	0.5301961	0.5339976	0.5378040	0.5416180	0.5454369	0.5530918	2
3	0.3569842	0.3603485	0.3637784	0.3672086	0.3706541	0.3741098	0.3810517	3
4	0.2722511	0.2754901	0.2787437	0.2820118	0.2852945	0.2885915	0.2962281	4
5	0.2214814	0.2246271	0.2277916	0.2309748	0.2341764	0.2373964	0.2438907	5
6	0.1876682	0.1907619	0.1938784	0.1970175	0.2001790	0.2033626	0.2097768	6
7	0.1635445	0.1666096	0.1697015	0.1728196	0.1759640	0.1791350	0.1855532	7
8	0.1454767	0.1484978	0.1515097	0.1545218	0.1575840	0.1610359	0.1674578	8
9	0.1314460	0.1344930	0.1375745	0.1406901	0.1438395	0.1470222	0.1534965	9
10	0.1202414	0.1232909	0.1263788	0.1295046	0.1326678	0.1358690	0.1423775	10
11	0.1110920	0.1141490	0.1172452	0.1203889	0.1235707	0.1267929	0.1333560	11
12	0.1034840	0.1065522	0.1096652	0.1128254	0.1160292	0.1192770	0.1259020	12
13	0.0970016	0.1001437	0.1032754	0.1064558	0.1096843	0.1129601	0.1196509	13
14	0.0915707	0.0946660	0.0978203	0.1010240	0.1042791	0.1075849	0.1143449	14
15	0.0868251	0.0899411	0.0931138	0.0963423	0.0996266	0.1029623	0.1097746	15
16	0.0826848	0.0858200	0.0890154	0.0922699	0.0955825	0.0989621	0.1058877	16
17	0.0790431	0.0821985	0.0854176	0.0886999	0.0920430	0.0954448	0.1024252	17
18	0.0758168	0.0789933	0.0822369	0.0855482	0.0889199	0.0923565	0.0994126	18
19	0.0729403	0.0761386	0.0794073	0.0827450	0.0861501	0.0896209	0.0967520	19
20	0.0704161	0.0736318	0.0769761	0.0803426	0.0837308	0.0871846	0.0943389	20
21	0.0680366	0.0712801	0.0746006	0.0779961	0.0814648	0.0850046	0.0922990	21
22	0.0658321	0.0691068	0.0724547	0.0758705	0.0794712	0.0830456	0.0904058	22
23	0.0637041	0.0670091	0.0703825	0.0738268	0.0774466	0.0811285	0.0885739	23
24	0.0617228	0.0650593	0.0684970	0.0720409	0.0756958	0.0794690	0.0869190	24
25	0.0600574	0.0634120	0.0668439	0.0704625	0.0741494	0.0779267	0.0854105	25
26	0.0585264	0.0618967	0.0653214	0.0688043	0.0723591	0.0760044	0.0835610	26
27	0.0571524	0.0605285	0.0640196	0.0675291	0.0711593	0.0748972	0.0824577	27
28	0.0559027	0.0592830	0.0628308	0.0664425	0.0701244	0.0738926	0.0814529	28
29	0.0547454	0.0581299	0.0617446	0.0654255	0.0691766	0.0730038	0.0805647	29
30	0.0536713	0.0570591	0.0607191	0.0645051	0.0683204	0.0721699	0.0800564	30
31	0.0526724	0.0560644	0.0598435	0.0636821	0.0675407	0.0714292	0.0793769	31
32	0.0517415	0.0551366	0.0589285	0.0627904	0.0666733	0.0705922	0.0785399	32
33	0.0508724	0.0542706	0.0580655	0.0619400	0.0658467	0.0697962	0.0777481	33
34	0.0500597	0.0534608	0.0572589	0.0611354	0.0650666	0.0690539	0.0772007	34
35	0.0492994	0.0527037	0.0565047	0.0603717	0.0643280	0.0683404	0.0763530	35
36	0.0485842	0.0520009	0.0558038	0.0596435	0.0636244	0.0676618	0.0756713	36
37	0.0479133	0.0513336	0.0551394	0.0589396	0.0629499	0.0670034	0.0750269	37
38	0.0472861	0.0507091	0.0545177	0.0582842	0.0623222	0.0663981	0.0743951	38
39	0.0467027	0.0501285	0.0539307	0.0576646	0.0620799	0.0661793	0.0738068	39
40	0.0461622	0.0495825	0.0533822	0.0570782	0.0614708	0.0655615	0.0732590	40
41	0.0456622	0.0490744	0.0528716	0.0565228	0.0608909	0.0649959	0.0727506	41
42	0.0452043	0.0486102	0.0524087	0.0560142	0.0603406	0.0644634	0.0722790	42
43	0.0447825	0.0481869	0.0519824	0.0555393	0.0598114	0.0639531	0.0718359	43
44	0.0443977	0.0478045	0.0515970	0.0550963	0.0593061	0.0634706	0.0714199	44
45	0.0440534	0.0474625	0.0512520	0.0546917	0.0589313	0.0630606	0.0710293	45
46	0.0437451	0.0471591	0.0509447	0.0543282	0.0585950	0.0627398	0.0706600	46
47	0.0434662	0.0468721	0.0506533	0.0539944	0.0582801	0.0624447	0.0703100	47
48	0.0432136	0.0466317	0.0504188	0.0536818	0.0580000	0.0621877	0.0700000	48
49	0.0429817	0.0464057	0.0501977	0.0534007	0.0577444	0.0619500	0.0697222	49
50	0.0427637	0.0461922	0.0500000	0.0531500	0.0575000	0.0617222	0.0695000	50
51	0.0425561	0.0459899	0.0498111	0.0529222	0.0572778	0.0615000	0.0692778	51
52	0.0423581	0.0457969	0.0496222	0.0527000	0.0570556	0.0612778	0.0690556	52
53	0.0421691	0.0456089	0.0494333	0.0524889	0.0568444	0.0610556	0.0688333	53
54	0.0419891	0.0454269	0.0492444	0.0522889	0.0566333	0.0608333	0.0686111	54
55	0.0418111	0.0452449	0.0490556	0.0520944	0.0564333	0.0606333	0.0684000	55
56	0.0416361	0.0450669	0.0488667	0.0519056	0.0562444	0.0604444	0.0682000	56
57	0.0414641	0.0448929	0.0486833	0.0517222	0.0560556	0.0602556	0.0680000	57
58	0.0412961	0.0447209	0.0485000	0.0515444	0.0558778	0.0600778	0.0678000	58
59	0.0411321	0.0445489	0.0483167	0.0513667	0.0556944	0.0598944	0.0676000	59
60	0.0409721	0.0443809	0.0481333	0.0511889	0.0555167	0.0597167	0.0674000	60

TABLE 87.—*Bid on a bond for \$100 to realize a given net income, interest payable semiannually.*

INTEREST 3½%.

Net income.	5 years.	10 years.	15 years.	20 years.	25 years.	30 years.
3.00	102.31	104.29	106.00	107.48	108.75	109.85
3.10	101.84	103.42	104.77	105.93	106.92	107.78
3.20	101.38	102.55	103.55	104.41	105.14	105.76
3.30	100.91	101.69	102.35	102.91	103.39	103.79
3.40	100.46	100.84	101.17	101.44	101.68	101.87
3.50	100.00	100.00	100.00	100.00	100.00	100.00
3.60	99.55	99.17	98.85	98.58	98.36	98.17
3.70	99.09	98.34	97.71	97.19	96.76	96.39
3.80	98.65	97.52	96.59	95.82	95.19	94.66
3.90	98.20	96.71	95.49	94.48	93.66	92.96
4.00	97.75	95.91	94.40	93.16	92.14	91.31
4.10	97.31	95.12	93.33	91.86	90.67	89.70
4.20	96.87	94.33	92.27	90.59	89.23	88.12
4.30	96.44	93.55	91.23	89.34	87.83	86.59
4.40	96.00	92.78	90.19	88.11	86.44	85.09
4.50	95.57	92.02	89.18	86.90	85.08	83.63
4.60	95.14	91.26	88.18	85.72	83.76	82.20
4.70	94.71	90.51	87.19	84.55	82.46	80.80
4.80	94.28	89.77	86.21	83.40	81.19	79.44
4.90	93.86	89.04	85.26	82.28	79.95	78.12
5.00	93.44	88.31	84.30	81.17	78.73	76.82

INTEREST 4%.

Net income.	5 years.	10 years.	15 years.	20 years.	25 years.	30 years.
3.00	104.61	108.58	112.01	114.96	117.50	119.69
3.10	104.14	107.99	110.73	113.34	115.58	117.50
3.20	103.67	106.80	109.47	111.75	113.70	115.35
3.30	103.20	105.92	108.23	110.19	111.85	113.27
3.40	102.74	105.05	107.00	108.66	110.06	111.23
3.50	102.28	104.19	105.80	107.15	108.29	109.24
3.60	101.82	103.33	104.60	105.67	106.56	107.30
3.70	101.36	102.49	103.43	104.21	104.87	105.41
3.80	100.90	101.65	102.27	102.78	103.21	103.56
3.90	100.45	100.83	101.13	101.38	101.59	101.76
4.00	100.00	100.00	100.00	100.00	100.00	100.00
4.10	99.55	99.19	98.89	98.64	98.45	98.23
4.20	99.11	98.38	97.79	97.31	96.92	96.61
4.30	98.66	97.58	96.71	96.00	95.43	94.97
4.40	98.22	96.79	95.64	94.72	93.97	93.37
4.50	97.78	96.01	94.59	93.45	92.54	91.81
4.60	97.35	95.28	93.55	92.21	91.14	90.29
4.70	96.91	94.47	92.53	90.99	89.77	88.80
4.80	96.48	93.71	91.53	89.79	88.42	87.35
4.90	96.05	92.95	90.53	88.61	87.11	85.93
5.00	95.62	92.21	89.53	87.45	85.82	84.55

INTEREST 4½%.

Net income.	5 years.	10 years.	15 years.	20 years.	25 years.	30 years.
3.00	106.92	112.88	118.01	122.44	126.26	129.54
3.10	106.44	111.96	116.69	120.75	124.23	127.22
3.20	105.96	111.05	115.39	119.09	122.26	124.95
3.30	105.49	110.15	114.11	117.47	120.32	122.74
3.40	105.02	109.26	112.84	115.87	118.43	120.59
3.50	104.55	108.38	111.59	114.80	116.57	118.48
3.60	104.08	107.50	110.30	112.75	114.76	116.43
3.70	103.62	106.64	109.15	111.24	112.68	114.42
3.80	103.16	105.78	107.95	109.74	111.23	112.47
3.90	102.70	104.93	106.77	108.28	109.53	110.56
4.00	102.25	104.09	105.60	106.84	107.86	108.89
4.10	101.79	103.25	104.45	105.42	106.22	107.17
4.20	101.34	102.43	103.31	104.08	104.63	105.09
4.30	100.89	101.61	102.19	102.66	103.05	103.35
4.40	100.44	100.80	101.09	101.32	101.51	101.66
4.50	100.00	100.00	100.00	100.00	100.00	100.00
4.60	99.56	99.21	98.93	98.70	98.52	98.33
4.70	99.12	98.42	97.88	97.43	97.08	96.80
4.80	98.68	97.64	96.82	96.17	95.66	95.26
4.90	98.25	96.87	95.79	94.94	94.27	93.75
5.00	97.81	96.10	94.77	93.72	92.91	92.37

TABLE 37.—*Bid on a bond for \$100 to realize a given net income, interest payable semiannually—Continued.*

INTEREST 8%.

Net income.	5 years.	10 years.	15 years.	20 years.	25 years.	30 years.
3.00	108.22	117.17	124.02	129.92	135.00	139.38
3.10	108.74	116.28	122.65	128.16	132.89	136.98
3.20	108.26	115.30	121.81	126.44	130.81	134.65
3.30	107.78	114.38	119.99	124.75	128.79	132.22
3.40	107.30	113.47	118.68	123.08	126.80	129.94
3.50	106.83	112.56	117.89	121.45	124.86	127.72
3.60	106.35	111.67	116.12	119.84	122.95	125.55
3.70	105.88	110.78	114.86	118.26	121.08	123.44
3.80	105.42	109.91	113.62	116.70	119.26	121.87
3.90	104.95	109.04	112.40	115.18	117.47	119.85
4.00	104.49	108.18	111.20	113.68	115.71	117.38
4.10	104.03	107.32	110.01	112.20	113.99	115.45
4.20	103.57	106.48	108.84	110.75	112.31	113.67
4.30	103.12	105.64	107.68	109.33	110.66	111.74
4.40	102.67	104.81	106.54	107.93	109.04	109.94
4.50	102.22	103.99	105.41	106.55	107.46	108.19
4.60	101.77	103.18	104.30	105.19	105.91	106.47
4.70	101.32	102.37	103.20	103.86	104.38	104.80
4.80	100.88	101.57	102.12	102.55	102.89	103.16
4.90	100.44	100.78	101.05	101.27	101.43	101.55
5.00	100.00	100.00	100.00	100.00	100.00	100.00
INTEREST 6%.						
3.50	111.38	120.94	128.98	135.74	141.43	146.20
3.60	110.89	120.01	127.68	134.01	139.84	145.81
3.70	110.41	119.08	126.80	132.80	137.80	143.47
3.80	109.93	118.16	124.98	130.63	135.80	139.18
3.90	109.46	117.25	123.68	128.98	133.84	136.94
4.00	108.98	116.35	122.40	127.86	131.42	134.78
4.10	108.51	115.46	121.18	125.76	129.54	132.63
4.20	108.04	114.58	119.89	124.19	127.70	130.84
4.30	107.58	113.70	118.65	122.65	125.89	128.50
4.40	107.11	112.83	117.43	121.14	124.11	126.51
4.50	106.65	111.97	116.23	119.65	122.38	124.55
4.60	106.19	111.12	115.06	118.18	120.67	122.66
4.70	105.73	110.28	113.88	116.74	119.00	120.80
4.80	105.28	109.44	112.73	115.32	117.36	118.98
4.90	104.83	108.61	111.59	113.92	115.76	117.20
5.00	104.38	107.79	110.47	112.55	114.18	115.45
5.25	103.26	106.78	107.72	109.22	110.38	111.27
5.50	102.16	105.81	105.03	106.02	106.75	107.81
5.75	101.07	104.88	102.49	102.95	103.29	103.55
6.00	100.00	100.00	100.00	100.00	100.00	100.00

TREATISES ON ROAD, BRIDGE, AND CULVERT CONSTRUCTION AND ALLIED SUBJECTS¹

- ADAMS, HENRY. Theory and practice in designing. New York, N. Y. 1911.
- ADAMS, HENRY. Reinforced concrete construction in theory and practice, and elementary manual for students and others, by HENRY ADAMS and ERNEST R. MATTHEWS. London, England, 1911.
- AGANA, MARCELINO. The value of good roads. From the *Philippine Agricultural Review*, October, 1909. Extract from *Philippine Education*. Vol. VI, no. 1, June, 1909.
- AITKEN, THOMAS. Irish Roads Improvement Association. Good roads; how to make and how to maintain them. Efficiency with economy. Belfast, Ireland, 1902. Publishers, W. and G. Baird. Contains also: Constitution of Irish Roads Improvement Association.
Road making and maintenance: a practical treatise for engineers, surveyors, and others. With an historical sketch of ancient and modern practice. London, 1907. Charles Griffin and Company.
- ALLEN, JAMES LANE. The blue-grass region of Kentucky and other Kentucky articles. New York, N. Y., 1899.
- American Academy of Political and Social Science, Philadelphia, Pa. The New South. 1910.
- American Highway Association, Washington, D. C. The official good roads year-book of the United States. 1912-13-14-15.
- American Automobile Association, New York, N. Y. The automobile official blue book, vol. 6, New York, N. Y., 1914, also numerous maps. Automobile Blue Book Publishing Company.
- American Civil Engineer's Pocketbook. Second edition. New York, N. Y., 1912, John Wiley and Sons.
- American Road Builders' Association. Proceedings, 1st-9th. New York N. Y., 1904-1914. Published by the Association, 150 Nassau Street.
- American Road Congress, Richmond, Va., 1911. Atlantic City, N. J., 1912, Detroit, Mich., 1913, Atlanta, Ga., 1914. Papers, addresses and resolutions.
- American School of Correspondence, Chicago. Bridge engineering: roof trusses; a manual of practical instruction in the calculation and design of steel truss and girder bridges for railroads and highways. By FRANK O. DUFOUR. Chicago, Ill., 1908. Cyclopedia of civil engineering. Vol. 1-8. Chicago, Ill., 1909.
- American Society for Testing Materials. Standard specifications for structural steel bridges. Adopted August 16, 1909. Philadelphia, Pa.
- American Society of Civil Engineers. The maintenance of macadam and other roads. An informal discussion at the annual convention, June 25, 1908. (Reprinted from Transactions V. 61.)

¹ Only modern works in English, which are easily obtainable, have been given in this list. Articles in periodicals, which are both numerous and valuable, and publications of the various State organizations and federal departments have been excluded. The publications of the Office of Public Roads and Rural Engineering, U. S. Department of Agriculture, are given in a separate list, page 10.

- American Society of Engineering Contractors. Advance copy of papers to be presented before the Society at their first annual convention to be held at the Coliseum, St. Louis, Mo., 1910. (New York, N. Y., 1910.) (Includes: Work preliminary to road construction and street pavement maintenance, by George C. Warren . . .)
- ANDREWS, EWART SIGMUND. Elementary principles of reinforced concrete construction; a text book for the use of students, engineers, architects and builders. London, England, 1912.
- ANDREWS, HIRAM B. The design of reinforced concrete slabs, beams and columns. Boston, Mass., 1909.
- ANDREWS, HORACE. Earth settlement in city streets. 1906. Paper read before American Society of Municipal Improvements.
- Appleton's new practical cyclopedia. New York, N. Y., 1910.
- Association of American Portland Cement Manufacturers, Philadelphia, Pa. Concrete highways. Philadelphia, Pa., 1913.
- Association of American Portland Cement Manufacturers, Philadelphia. Concrete roads in Wayne County. By EDWARD N. HINNS. Chicago, Ill., 1912.
- Association for Standardizing Paving Specifications. Annual report. Proceedings, 1st-3d. Chicago, Ill., 1910-1912. Published by the Association, 5917 Winthrop Avenue, Chicago.
- Association of Western Portland Cement Manufacturers. Highways and byways. An address given by P. W. Rochester before the Washington State Good Roads Convention in Tacoma, Washington, December 5th, 6th and 7th, 1912.
- BAKER, IRA OSBORN. A treatise on masonry construction. Tenth edition. New York, N. Y., 1910. John Wiley and Sons.
- A treatise on roads and pavements second edition New York, N. Y., 1913.
- BALET, JOS. W. Analysis of elastic arches, three-hinged, two-hinged and hingeless, of steel, masonry and reinforced concrete. New York, 1908. Engineering News Publishing Company.
- BALLEN, DOROTHY. Bibliography of road-making and roads in the United Kingdom. With an introduction by Sir George Gibb. London, England, 1914.
- BALLINGER, WALTER F., and E. G. PERROT. Inspector's handbook of reinforced concrete. New York, N. Y., 1909. Engineering News Publishing Company.
- BARNARD, GEO. D. & Co. Road overseer's commission with road law. St. Louis, Mo., 1893.
- BAUERMAN, HILARY. Text-book of systematic mineralogy. Fifth impression. London, England, 1903.
- BELLASIS, E. S. River and canal engineering. Spon and Chamberlain, New York, 1913.
- BLACK, WILLIAM MURRAY. The United States public works. Containing a summary of the methods of construction and character of materials and plant used in the public works under the charge of the War and Treasury Departments, and of the Commissioner of the District of Columbia, including works of river and harbor improvement. New York, N. Y., 1895.
- BLANCHARD, A. H., DROWNE, H. B. Text-book on highway engineering. New York.
- BLANCHARD, ARTHUR H. The construction and maintenance of European roads. Reprinted from the *Journal of Massachusetts Highway Association*, June, 1911.
- Elements of highway engineering. John Wiley and Sons, Inc., New York, 1915.

- BOLLER, ALFRED P.** Practical treatise on the construction of iron highway bridges, for the use of town committees. Fourth edition. New York, N. Y., 1901. John Wiley and Sons.
- BOORMAN, T. HUGH.** Asphalts, their sources and utilizations; asphalt for dustless roads; recent improvements in asphalt industries, together with addenda treating on general waterproof construction. New York, N. Y., 1908. Published by Wm. T. Comstock.
- BOULNOIS, H. PERCY.** Practical road engineering for the new traffic requirements. Compiled from the Special "Roads" issues of the *Surveyor and Municipal and County Engineer*. London, England, 1910. The St. Bride's Press.
- BOWLES, OLIVER.** Tables for the determination of common rocks. New York, N. Y., 1910.
- BRANDT, C. E.** Road locating and building simplified. Cumberland, Md., 1908.
- BREED, CHARLES B.** The principles and practice of surveying. Vol. I. Elementary surveying. Vol. II. Higher surveying. By CHARLES B. BREED and GEORGE L. HOSMER. Vol. 1, third edition. Vol. 2, first edition. New York, N. Y., 1908. John Wiley and Sons.
- BRUCE, HENRY A. B.** Daniel Boone and the Wilderness road. New York, N. Y., 1910.
- BURR, WILLIAM H.** The design and construction of metallic bridges, by WILLIAM H. BURR and MYRON S. FALK. Second edition, revised. New York, N. Y., 1908. John Wiley and Sons.
- The elasticity and resistance of the materials of engineering. Sixth edition, revised and enlarged. New York, N. Y., 1911. John Wiley and Sons.
- The graphic method by influence lines for bridge and roof computations, by WILLIAM H. BURR and MYRON S. FALK. Second edition. New York, N. Y., 1909. John Wiley and Sons.
- Suspension bridges, arch ribs and cantilevers. 1st edition. New York, N. Y., 1913.
- BYRNE, AUSTIN T.** Inspection of the materials and workmanship employed in construction. Second edition, revised and enlarged. New York, N. Y., 1906. John Wiley and Sons.
- A treatise on highway construction, designated as a textbook and work of reference in the location, construction, or maintenance of roads, streets and pavements. Fifth revised and enlarged edition. New York, N. Y., 1907. John Wiley and Sons.
- CARPENTER, ROLLA C. and DIEDRICH, HERMANN.** Experimental engineering and manual for testing. Seventh edition, rewritten and enlarged. New York, N. Y., 1911. John Wiley and Sons.
- CARVER, THOMAS NIXON.** Principles of rural economics. Boston, Mass., 1911.
- CHAMBERLAIN, LAWRENCE.** The principles of bond investment. New York, N. Y., 1911. Holt and Company.
- CHUBB, JOSEPH H.** Concrete pavements: their cost and construction, with specifications. Chicago, Ill., 1910.
- CHURCH, IRVING PORTER.** Mechanics of engineering. Comprising statics and kinetics of solids; the mechanics of the materials of construction, or strength and elasticity of beams, columns, shafts, arches, etc., and the principles of hydraulics and pneumatics, with applications. New York, N. Y., 1894. John Wiley and Sons.
- COANE, JOHN MONTGOMERY and others.** Australasian roads, a treatise, practical and scientific, on the location, design, construction and maintenance of roads and pavements. Melbourne, 1908. Geo. Robertson and Company.

- COCHRAN, JEROME.** A treatise on the inspection of concrete construction. Chicago, Ill., 1913. Myron C. Clark Publishing Company.
- COOPER, THEODORE.** General specifications for steel highway and electric street railway bridges and viaducts. New and revised edition, by **BERNT BERGER.** New York, N. Y., 1909. Engineering News Publishing Company.
- CORTRELL, ELMER LAWRENCE.** Allowable pressure on deep foundations. New York, N. Y., 1907. John Wiley and Sons.
- CROSS, WHITMAN.** Quantitative classification of igneous rocks based on chemical and mineral characters. By **WHITMAN CROSS, JOSEPH P. IDDINGS, LOUIS V. PISSON, and HENRY S. WASHINGTON.** Chicago, Ill., 1903. Published by the University of Chicago Press.
- Daughters of the American Revolution, Missouri.** The old trails road; the national highway as a monument to the pioneer men and women, proposed by the Missouri D. A. R., 1911.
- DAVIES, JOHN P.** Engineering office systems and methods McGraw-Hill Book Company, New York, 1915.
- DAVIS, A. C.** Portland cement. Second edition, revised and enlarged. London, England, 1909.
- DIAMANT, SIDNEY.** Curves for calculating beams, channels and reactions. New York, N. Y., 1900. The McGraw Publishing Company.
- DODGE, G. F.** Diagrams for designing reinforced concrete structures, including diagrams for reactions and strengths of steel beams. New York, N. Y., 1910.
- DUBOIS, A. JAY.** The mechanics of engineering, New York, N. Y. Jno. Wiley and Sons.
- DUMASUEL, EDMUND G. F. R.** Manual of reinforced concrete construction New York, N. Y., 1910.
- DURHAM, HENRY WELLES,** formerly Chief Engineer, Bureau of Highways, Borough of Manhattan, New York City. Report on street paving and maintenance in European cities.
- EABLE, ALICE MORSE.** Stage coach and tavern days. New York, N. Y., 1900.
- ECKEL, EDWIN C.** Building stones and clays; their origin, character, and examination. New York, N. Y., 1912.
- Cements, limes, and plasters; their materials, manufacture, and properties.** New York, N. Y., 1906. John Wiley and Sons.
- EDINBURGH.** Royal Scottish Museum. An introduction to petrology and guide to the collection of rocks. Edinburgh, Scotland, 1909.
- ELLIOTT, BYRON K. and WILLIAM F. ELLIOTT.** A treatise on the law of roads and streets. Indianapolis, Ind., 1911. Bobbs-Merrill Company.
- ENDE, MAXAM.** Long span bridge. Chatham, England, 1905. *Professional Papers of the Corps of Royal Engineers.* Fourth series. Vol. I, paper 2.
- Engineering Standard Committees, London.** British standard specifications for Portland cement. Second issue. London 1907.
- FABER, OSCAR.** Reinforced concrete design, by **OSCAR FABER and P. G. BOWIE.** London, England, 1912.
- FALE, MYRON S.** Cements, mortars, and concretes; their physical properties. New York, N. Y., 1904. Published by M. C. Clark.
- FERGUSON, WM. B.** Estimating the cost of work. Engineering Magazine Company, 1915.
- FINLAY, GEORGE I.** Introduction to the study of igneous rocks. New York, N. Y., 1913. McGraw-Hill Book Company.
- FISH, JOHN C. L.** Earthwork haul and overhaul including economic distribution. New York, N. Y., 1913. John Wiley and Sons.
- FLAGG, ERNEST.** Roads and pavements. New York, N. Y., 1910.

- FOSTER, WOLCOTT C.** A treatise on wooden trestle bridges. Third revised and enlarged edition. New York, N. Y., 1903. John Wiley and Sons.
- FOWLER, CHARLES EVAN.** Law and business of engineering and contracting with numerous forms and blanks for practical use. New York, N. Y., 1909. McGraw Publishing Company.
- Ordinary foundations. Including the coffer-dam process for piers. Second edition revised and enlarged. New York, N. Y., 1907. John Wiley and Sons.
- FROST, HARWOOD.** The art of roadmaking, treating of the various problems and operations in the construction and maintenance of roads, streets and pavements. New York, N. Y., 1910. Engineering News Publishing Company.
- Good engineering literature. What to read and how to write with suggestive information on allied topics. Chicago, Ill., 1911. Chicago Book Company.
- Compilation. Notes on the literature of roads, streets and pavements, reprinted from the *Engineering Digest* (New York) with list of current works on earthwork, blasting, highway bridges, tunneling and allied lines. New York, N. Y., 1909.
- FRYE, ALBERT I.** Civil engineer's pocket-book. A reference book for engineers, contractors and students, containing rules, data, methods, formulas and tables. New York, 1913.
- GENTRY, ELIZABETH BUTLER,** National Chairman. A report of the National Old Trails Road Committee to Continental Congress, April 19, 1915. National Society Daughters of the American Revolution, Washington, D. C., 1915.
- GILLESPIE, W. M.** A manual of the principles and practice of roadmaking; comprising the location, construction and improvement of roads (common, macadam, paved, plank, etc.), and railroads. New York, N. Y., 1871. A. S. Barnes and Company.
- GILLETTE, HALBERT POWERS.** Handbook of cost data for contractors and engineers. Chicago, Ill., 1910. Myron C. Clark, Publisher.
- Rock excavation, methods and cost. New York, N. Y., 1904. Myron C. Clark, Publisher.
- The economics of road construction. New York, N. Y., 1906. Engineering News' Publishing Company.
- GLEN, WILLIAM CUNNINGHAM.** The law relating to highways, highway authorities, bridges, railways crossing highways, locomotives on highways, and tramways. By the late W. C. GLEN and by the editor of the present edition. Second edition by Alex. Glen, London, England, 1897.
- GODFREY, EDWARD.** Structural engineering. Book 1. Tables. Pittsburgh, Pa., 1905.
- Great Britain Local Government Board. Annual report. London.
- Great Britain Road Board. Publications, 1910-1913. London.
- Great Britain. Parliament. House of Commons. Select committee on traction engines on roads. Report from the select committee on traction engines on roads; together with the proceedings of the committee, minutes of evidence, appendix and index. London, England, 1896.
- GREENWELL, ALLAN, and ELSDEN, J. V.** Roads: their construction and maintenance with special reference to road materials. London, 1901. Published by D. Fouldrinier, Builder Office, Catherine St., N. C. London.

- GARINER, J. E. General specifications for bridges. Part 1. Steel stationary bridges. Part 2. Movable bridges. Part 3. Substructures and concrete bridges. (Baltimore, Md.) 1911.
- HANSON, E. S. Concrete roads and pavements. Chicago, Ill. 1913. Cement Era Publishing Company.
- HARDY, RIVES B. A digest of the laws and practice of all the States of the Union in reference to the employment of convicts. Richmond, Va., 1911. Published by the State.
- HARGER, WILSON G. Handbook for highway engineers containing information ordinarily used in the design and construction of roads warranting an expenditure of \$5000 to \$30,000 per mile. Part I. Theory of design. Part II. Practice of design and construction. By WILSON G. HARGER and EDMUND A. BONNEY. New York, N. Y., 1912. McGraw-Hill Book Company.
- HARRIS, G. MONTAGU. The first international road congress. Paris, 1908. MONTAGU HARRIS and H. T. WAKELAM. London, England. Wyman and Sons.
- HEIDENREICH, E. Lee. Engineers' pocketbook of reinforced concrete. Chicago, Ill., 1909. Myron C. Clark, Publisher.
- HENRY, W. B. Practical cement work, and elementary treatise on cement construction. Atlanta, Ga., 1911.
- HERSCHEL, CLEMENS. The science of road making, by CLEMENS HERSCHEL. Construction and maintenance of roads, by EDWARD P. NORTH. New York, N. Y., 1894. Engineering News Publishing Company.
- HILL, CHARLES SHATTUCK. Concrete inspection; a manual of information and instructions for inspectors of concrete work, with standard and typical specifications. Chicago, Ill., 1909.
- HINES, EDWARD. Concrete roads. Reprinted from *Journal of the Western Society of Engineers*, Vol. XVII, no. 3, March, 1913.
- HOOLEY, E. PURNELL. Management of highways. London. Biggs and Company, 139-140, Salisbury Court, London, E. C.
- HOUGHTON, ALBERT ALLISON. Concrete bridges, culverts and sewers; a treatise illustrating and explanatory of the various types of solid and reinforced arch, slab and girder concrete bridges, with notes on construction. New York, N. Y., 1912.
- HOWE, MALVERD A. A treatise on arches. Second edition, revised and enlarged, New York, N. Y., 1906. John Wiley and Sons.
Symmetrical masonry arches, including natural stone, plain-concrete, and reinforced-concrete arches. New York, N. Y., 1906. John Wiley and Sons.
Retaining-walls for earth. Fourth edition revised and enlarged. New York, N. Y., 1907. John Wiley and Sons.
- HUBBARD, PREVOST. Dust preventives and road binders. New York, N. Y., 1910. John Wiley and Sons.
- HUDSON, CLARENCE W. Notes on plate-girder design. First edition New York, 1911. Wiley and Sons.
- HULBERT, ARCHER BUTLER. Historic highways of America. Sixteen Volumes. Cleveland, Ohio, 1902-05. The Arthur H. Clark Co.
Red-men's roads; the Indian thoroughfares of the Central West. Columbus, Ohio, 1900.
- HUSBAND, JOSEPH. Structural engineering. London, England, 1911.
- IDDINGS, JOSEPH PAXSON. Rock minerals, their chemical and physical characters and their determination in their sections, second edition. New York, N. Y., 1911. John Wiley and Sons.
- International Association of Road Congresses. First congress, Paris, 1908. Second congress, Brussels, 1910. Third Congress, London, 1913. Reports.

- International Correspondence School, Scranton, Pa. The concrete engineer's handbook; a convenient reference book. Scranton, Pa., 1911.
- International Road Congress, Brussels, 1910. Highway engineering as presented at the second international road congress, Brussels, 1910. By ARTHUR H. BLANCHARD and HENRY B. DROWNE. First edition. New York, N. Y., 1911.
- Irish Roads Congress. First. Dublin, 1910. Second, Dublin 1911. The Irish roads congress. Record of proceedings, Dublin, 1910-1911. Cahill and Company, 40 Lower Ormond Quay.
- Irish Roads Improvement Association. Important articles on road-making and maintenance. I. The making and maintenance of roads with special reference to Ireland, by P. C. Cowan. II. The economics of road management, by John Brown. III. Opinions of county surveyors on direct labour vs. the contract system. (Belfast, Ireland, 1906.) Published by *The Irish Engineering and Industrial Review*.
- JACOB, HENRY S. Structural details of elements of design in heavy framing. First edition New York, N. Y., 1909. John Wiley and Sons.
- JEBB, GEORGE ROBERT. A plea for better country roads. (Includes also, Country roads for modern traffic, by JOHN EATON BLACKWELL.) London, 1906. Published by The Institution of Civil Engineers.
- JEFFREYS, REES. Dust problem statistics; return of methods adopted and materials used by the local authorities of Great Britain to render the roads dustless during 1907-1908. Prepared for the Roads Improvement Association. London, England, 1906. Published by the Association 11, Albermarle Street, Piccadilly, London, W.
- JENES, JEREMIAH WHIPPLE. Road legislation for the American State. Baltimore, Md., 1889. Publications of Amer. Economic Assoc., 4 vol., no. 3.
- JOHNSON. Theory and practice of surveying. New York, John Wiley and Sons.
- JOHNSON, JOHN BUTLER. Engineering contracts and specifications. Third edition revised. New York, N. Y., 1902. Engineering News Publishing Company.
- The materials of construction. A treatise for engineers on the strength of engineering materials. Fourth edition, revised and enlarged. New York, N. Y., 1902. John Wiley and Sons.
- The theory and practice of modern framed structures. By J. B. JOHNSON, C. W. BRYAN, and F. E. TURNHAUSE. Ninth edition, rewritten. New York, N. Y., 1911. Wiley and Sons.
- The theory and practice of surveying. Sixteenth edition, revised and enlarged. New York, N. Y., 1906.
- JUDSON, WILLIAM PIERSON. City roads and pavements suited to cities of moderate size. Fourth edition. New York, N. Y., 1909. Engineering News Publishing Company.
- City roads and pavements, suited to Oswego, N. Y., 1894. R. J. Oliphant, Printer.
- Road preservation and dust prevention. New York, N. Y., 1908. Engineering News Publishing Company.
- KENT, WILLIAM. The mechanical engineers' pocket book. Eighth edition rewritten. New York, 1910. John Wiley and Sons.
- KERSTEN, C. Brücken in Eisenbeton . . . Teil II, Bogenbrücken. Wilhelm Ernst & Sohn, Berlin. 1913.
- KETCHUM, MILO SMITH. The design of highway bridges and the calculation of stresses in bridge trusses. New York, N. Y., 1908. Engineering News Publishing Com.
- Structural engineer's handbook. Data for the construction of steel bridges and buildings. McGraw-Hill Book Company, New York, 1914.

- KIDDER, FRANK E. The architect's and builder's pocket-book, 15th ed., revised, New York, N. Y., 1909. John Wiley and Sons.
- KING, D. WARD. Good roads at low cost. Written for the Pennsylvania Railroad Company, Philadelphia, Pa., 1910.
How to have good dirt roads. From October issue, *Technical World Magazine*, 1912.
- KIRBY, RICHARD S. The elements of specification writing. New York, N. Y., 1913. John Wiley and Sons.
- KUMMER, FREDERIC A. Modern wood pavements, creosote-resinate process, including a paper on recent experiences with wood pavements, by B. T. WHEELER. New York, N. Y., 1901. United States Wood Preserving Company.
- LANCASTER, SAMUEL C. The Columbia, America's great highway through the Cascade Mountains to the sea. Published by the author, Portland, Oregon. 1915.
- LARARD, C. E., AND GOLDING, H. A. Practical calculations for engineers . . . J. B. Lippincott Company, Philadelphia, 1914.
- LATHAM, FRANK. The construction of roads, paths, and sea defenses with portions relating to private street repairs, specification clauses, prices for estimating and engineers' replies to queries. London, 1903. The Sanitary Publishing Company, 5, Fetter Lane, London, E. C.
- LAW, HENRY and CLARK, D. K. The construction of roads and streets. With additional chapters by A. J. WALLIS-TAYLOR, London, 1901. Crosby Lockwood and Son, 7, Stationers Hall Court, Ludgate Hill.
- LAW, LEROY M. Empirical requirements in asphalt specifications. Baltimore, Md., 1913.
- LEONARD, JNO. B. The concrete bridge. A book on why the concrete bridge is replacing other forms of bridge construction. By John B. Leonard and W. P. Day. San Francisco, Cal., 1913.
- LORD, EDWIN C. E. The composition and properties of slag for road making. Reprinted from the *Proceedings of the Seventh International Congress of Applied Chemistry*. London, May 27, to June 2, 1909, section II. London, England, 1909.
- LOVEGROVE, E. J. Attrition tests of road-making stones; with petrological descriptions, by JOHN S. FLETT and J. ALLEN HOWE. London, 1906. The St. Bride's Press, St. Bride's House, 24 Bride Lane, Fleet Street, E. C.
- MCADAM, JOHN LOUDON. Remarks on the present system of road making with observations, deduced from practice and experience, with a view to a revision of the existing laws, and the introduction of improvement in the methods of making, repairing, and preserving roads, and defending the road funds from misapplication. Eighth edition. London, 1824. (Out of Print.)
- MCCULLOUGH, ERNEST. Reinforced concrete, Chicago, Ill., 1908.
- MCDANIEL, ALLEN BOYER. Excavating machinery. New York, N. Y., 1913. McGraw-Hill Book Company.
- MACNAIR, PETER. Introduction to the study of rocks and guide to the rock collections in Kelvingrove Museum. Glasgow, Scotland, 1911.
- MALLOCK, HENRY REGINALD ARNULPH. Construction and wear of roads. London, England, 1909. Excerpt, *Minutes of Proceedings of the Institution of Civil Engineers*, Session 1908-1909.
- MANSON, MARSDEN. A brief history of road conditions and legislation in California. American Society of Civil Engineers, *Transactions*, paper no. 926.
- MARBURG, EDGAR. Framed structures and girders. Theory and practice, vol. I, Stresses, pt. I. New York, N. Y., 1911. McGraw-Hill Book Company.

- MARSH, CHAS. P. Reinforced concrete. New York, D. Van Nostrand Company.
- MASON, HERBERT DELAVAN. Mason on highways containing the New York highway law and all constitutional and general statutory provisions relating to highways, highway officers, their powers and duties, including the good roads law of 1898 and 1901 and the motor vehicle law of 1904, all as amended to the end of the session of 1905, with annotations and forms. 4th edition. Albany, N. Y., 1905.
- Massachusetts Society for Promoting Agriculture. The law of the roadside. How to protect our landscape. Electric lines in public ways. Shade trees in public ways. Insect pests. Trespass to real estate. Second Edition, Boston, Mass. 1911.
- MAYBURY, HENRY PERCY. Recent development in road-traffic, road-construction and maintenance. London, England, 1911. Published by The Institution of Civil Engineers.
- MEADE, RICHARD KIDDER. Portland cement; its composition, raw materials, manufacture, testing and analysis. Second edition. Easton, Pa., 1911. The Chemical Publishing Company.
- MEEKER, EZRA. The ox team, or the old Oregon trail, 1802-1906. Omaha, Neb. 1906.
- MENSCH, L. J. The reinforced concrete pocket book. San Francisco, Calif., 1909. Myron C. Clark Publishing Company.
- MERRIMAN, MANSFIELD. Mechanics of materials. Tenth edition, rewritten and enlarged. New York, N. Y., 1906. John Wiley and Sons.
A testbook on roofs and bridges, pt. III, Bridge design. By MANSFIELD MERRIMAN and HENRY S. JACOBY. Fourth edition, rewritten. New York, N. Y., 1905. John Wiley and Sons.
- MILLER, CLAUDE HARRIS. Making paths and driveways. New York, N. Y., 1912.
- MOORE, HENRY LUDWELL. Laws of wages. The Macmillan Company. 1911.
- MOORE, LEWIS E. Design of plate girders. New York, 1913.
- MORRIS, CLYDE T. Designing and detailing of simple steel structures. *Ohio State University Civil Engineering Publications*. no. 3. Columbus, Ohio, 1910.
- MORRISON, CHARLES EDWARD. Highway engineering. First edition. New York, 1908. John Wiley and Sons.
- MORSCH, EMIL. Concrete-Steel construction. Authorized translation from the third (1906) German edition, revised and enlarged, by E. P. GOODRICH. New York, N. Y., 1909.
- MURDOCK, H. E. Strength of materials. John Wiley and Sons, New York, 1911.
- National Association of Cement Users. Proposed standard specifications for concrete road and street pavements. Philadelphia, Pa., 1910.
- National Free Labor Association. Series No. 1—Road work. New York, N. Y., 1913.
- National Paving Brick Manufacturers' Association. Directions for laying vitrified brick street pavements. Specifications. Indianapolis, Ind., 1911.
- New York. Department of Efficiency and Economy. Annual report concerning matters relating to the construction and maintenance of public highways. Report of advisory board by A. H. Blanchard and Prévost Hubbard. 1915.
- Ohio Good Roads Federation, 515 Hartman Building, Columbus, Ohio. Road laws of Ohio, 1915.

- OSTRUP, JOHN C. Standard specifications for structural steel, timber, concrete, and reinforced concrete. New York, N. Y., 1911. McGraw-Hill Book Company.
- PAGE, LOGAN WALLER. Macadam roads and their preservation. Chicago, Ill., 1909. Western Society of Engineers.
- Portland cement concrete roads. Chicago, Ill., 1912. Presented at the spring meeting of Association of American Portland Cement Manufacturers.
- Roads, paths and bridges. New York, N. Y., 1912. Sturgis and Walton.
- Rural highways. A paper presented before the International Engineering Congress, September 20-25, 1915, San Francisco, Cal. 1915.
- PARNELL, SIR HENRY. A treatise on roads. Second edition. London, England, 1838. (Out of Print.)
- PATERSON, DANIEL. A new and accurate description of all the direct and principal cross roads in England and Wales. London, England, 1786.
- PATTON, W. M. A practical treatise on foundations, explaining fully the principles involved, supplemented by articles on the use of concrete in foundations. Second edition, enlarged. New York, N. Y., 1909. John Wiley and Sons.
- PAUL, E. M. Manual of road construction and maintenance. Chatham, England, Royal Engineer's Institute. 1908.
- PORTER, HARRY FRANKLIN. Concrete, its composition and use. Cleveland, Ohio, 1909.
- Pratt and Mackenzie's law of highways: being the law of highways, main roads, streets and bridges. Part I. Law of highway independent of statute. Part II. Statutes relating to highways, main roads, streets and bridges. By WILLIAM W. MACKENZIE. 16th edition. London, England, 1911.
- PRELINT, CHARLES. Earth and rock excavation. D. Van Nostrand. New York, 1906.
- RADFORD, WILLIAM A. Cement and how to use it. Chicago, Ill., 1910.
- RENEVE, CHARLES S. Effect of diameter of bitumen holder on the penetration test. International Association for Testing Materials. Sixth. New York, N. Y., 1912.
- REID, HOMER A. Concrete and reinforced concrete construction. New York, N. Y., 1907. Myron C. Clark Publishing Company.
- REUTERDAHL, ARVID. Theory and design of reinforced concrete arches. Chicago, Ill., 1908. Myron C. Clark Publishing Company.
- Asphalt construction for pavements and highways. New York, N. Y. 1913. McGraw-Hill Book Company.
- RICHARDSON, CLIFFORD. The modern asphalt pavement. New York, N. Y., 1908. John Wiley and Sons.
- Science in the service of highway engineering. Reprinted from the *Popular Science Monthly*, April, 1912. New York, N. Y., 1912.
- Street traffic in New York City, 1885 and 1904. Reprinted from *American Society of Civil Engineers, Trans.* 1906, vol. vii, 191, 1906, Paper no. 1031.
- RINGS, FREDERICK. Reinforced concrete bridges New York, N. Y., D. Van Nostrand Company. Reinforced concrete, theory and practice. London, England, 1910.
- RINGWALT, J. L. Development of 'transportation systems in the United States. Philadelphia, Pa., 1888. Published by the Author, Railway World Office, 420 Library St.
- Roads Improvement Association. The movement for wider and better roads. London, England, 1903.

- ROCKWOOD, NATHAN C. One hundred fifty years of road building in America. Engineering News, New York, 1914.
- ROSENBUSCH, HARRY. Microscopical physiography of the rock-making materials; an aid to the microscopical study of rocks. Translated by J. P. Iddings. New York, N. Y., 1889. Second edition.
- RYVES, REGINALD. The king's highway, the nature, purpose and development of roads and road systems. London, England, 1908. The St. Bride's Press.
- SHARIGHT, THOMAS B. The Old Pike. A history of the National road with incidents, accidents, and anecdotes thereon. Uniontown, Pa., 1894. Published by the Author.
- SHALER, NATHANIEL SOUTHGATE. American highways; a popular account of their conditions and of the means by which they may be bettered. New York, N. Y., 1896. The Century Company.
- The geology of the road-building stones of Massachusetts, with some consideration of similar materials from other parts of the United States. Washington, D. C., 1895. Extract from the sixteenth annual report of the U. S. Geological Survey, 1894-95, pt. 2.
- Preliminary report on the geology of the common rocks of the United States. Washington, D. C., 1895. Extract from the fifteenth annual report of the U. S. Geological Survey, 1893-94.
- SKINNER, FRANK W. Types and details of bridge construction. Part I. Arch Spans. Part II, Plate Girders. New York, N. Y., 1904-06. McGraw-Hill Book Company.
- SMITH, JONAH WALKER. Dustless roads. Tar macadam. A practical treatise for engineers, surveyors and others. London, England, 1900. Chas. Griffin and Company, Exeter St., Strand.
- The improvement of highways to meet modern conditions of traffic. And recent developments in road-traffic, road-construction and maintenance. By J. S. SMITH and H. P. MAYBURY. Edited by J. H. T. TUDARBURY. Excerpt *Minutes of the Proceedings of the Institute of Civil Engineers*, vol. clxxxvi. Session 1910-11, pt. iv. London, England, 1911.
- SOMMER, ALBERT. The character of bitumen for road surfaces. Reprint from *Proceedings of the American Society for Testing Materials*, vol. ix, 1909. Philadelphia, Pa., 1909.
- Methods of asphalt examination. Reprint from the *Journal of Industrial and Engineering Chemistry*, vol. 2. no. 5, May, 1910.
- SOULA, FRANK. Macadam roads and road metals. Reprinted from the *University of California Chronicle*, vol. ii, no. 5. Berkeley, Calif., 1899.
- SPALDING, FREDERICK PUTNAM. A textbook on roads and pavements. Fourth edition, revised and enlarged. New York, N. Y., 1912. John Wiley and Sons.
- SPEED, THOMAS. The Wilderness Road, a description of the routes of travel by which the pioneers and early settlers first came to Kentucky. Prepared for the Filson Club. Louisville, Ky., 1886.
- STEINMAN, DAVID BERNARD. Suspension bridges and cantilevers, their economic proportions and limiting spans. New York, N. Y., 1911.
- STONE, ROY. New roads and road laws in the United States. Van Nostrand, 1894.
- SYFHERD, W. O. A handbook of English for engineers. Scott, Foresman and Company, Chicago, 1903.
- TAYLOR, ARTHUR. Some experiments with mortars and concrete mixed with asphaltic oils. By Messrs. ARTHUR TAYLOR and THOMAS SANBORN with discussion by Messrs. LOGAN WALLER PAGE, WILLIAM J. BOUCHER, A. T. GOLDBECK, and ARTHUR TAYLOR. 1913. Reprinted from *Transactions, American Society of Civil Engineers*.

- TAYLOR, FREDERICK W.** Concrete costs. By F. W. TAYLOR and S. E. THOMPSON. New York, N. Y., 1912. John Wiley and Sons.
- TAYLOR, FREDERICK W.** A treatise on concrete, plain and reinforced. Second edition, New York, N. Y., 1912. John Wiley and Sons.
- THOMSON, W. CHASE.** Bridge and structural design. New York, Engineering News Publishing Company. John Wiley and Sons.
- THURSTON, ROBERT H.** The materials of engineering.
- TILLSON, GEORGE WILLIAM.** Street pavements and paving materials. A manual of city pavements; the methods and materials of their construction. Second edition. New York, N. Y., 1912. John Wiley and Sons.
- TOMPKINS, D. A.** Road building and broad tires; a brief history of Mecklenburg's good roads, together with some arguments in favor of broad tires for all vehicles. Charlotte, N. C., 1899. Observer Printing and Publishing House.
- Road-building in a southern state. Reprinted from the *Engineering Magazine*, February, 1894. Charlotte, N. C., 1897.
- TRAUTWINE, JOHN C.** The civil engineer's pocket-book, revised by J. C. TRAUTWINE, JR., and J. C. TRAUTWINE, 3rd. Eighteenth edition. New York, N. Y., 1904. John Wiley and Sons.
- TUCKER, JAMES IRWIN.** Contracts in engineering. The interpretation and writing of engineering-commercial agreements. New York, McGraw-Hill Company.
- TURNHAUSE, F. E. and MAURER, E. R.** Principles of reinforced concrete construction. Second edition, revised and enlarged. New York, N. Y., 1910. John Wiley and Sons.
- TYRELL, HENRY GRATTAN.** Artistic bridge design. With an introduction by THOMAS HASTINGS. Chicago, Ill., 1912. M. C. Clark Publishing Company.
- Concrete bridges and culverts for both railroads and highways, Chicago, Ill., 1909. M. C. Clark Publishing Company.
- USBORN, P. O. G.** The design of simple steel bridges. Van Nostrand, 1912.
- WADDELL, J. A. L.** Specifications for steel bridges. Taken from *De Pontibus*. First edition. New York, N. Y., 1906. John Wiley and Sons.
- WAIT, JOHN CASSAN.** Engineering and architectural jurisprudence. A presentation of the law of construction for engineers, architects, contractors, builders, public officers, and attorneys at law. New York, N. Y., 1910. John Wiley and Sons.
- The law of contracts. New York, 1910. John Wiley and Sons.
- The law of operations preliminary to construction in engineering and architecture. Rights in real property. Boundaries, easements, and franchises. New York, N. Y., 1900. John Wiley and Sons.
- WATSON, WILBUR J.** General specifications for concrete bridges. Second edition. New York, N. Y., 1910. Engineering News Publishing Company.
- WEBB, SIDNEY and BEATRICE WEBB.** English Local Government: The Story of the King's Highway. London and New York, 1913. Longmans, Green and Company.
- WELLER, FERDINAND.** Notice about the so-called "Kleinpflaster" (Small setts, durax stones). Published by Aktiengesellschaft Bornholmer Granitwerke, Hamburg, Alsterdaman. 17.
- WEINSCHENK, ERNST.** Petrographic methods. The authorised English translation of Parts I-II. New York, N. Y., 1912. McGraw-Hill Book Company.
- WEST, PERCY C. H.** The modern manufacture of Portland cement. New York, N. Y., 1910. McGraw-Hill Book Company.

- WESTON, EUSTACE M. Rock drills; design, construction, and use. New York, N. Y., 1910. McGraw-Hill Book Company.
- WHEELER, HERBERT ALLEN. Vitriified paving brick, a review of present practice in the manufacture, testing and uses of vitriified paving brick. Second edition. Indianapolis, Ind. 1910.
- WHEELER, W. H. The repair and maintenance of roads. London, England, 1900. Published by the Roads Improvement Association.
- WHINERY, S. Specifications for street roadway pavements. New York, N. Y., 1907. McGraw-Hill Book Company.
- WHITE, THEO. F. Oiled Roads and streets. Crude petroleum for making roads and laying dust. Redlands, Calif., 1911. Published by The Citrograph.
- WHITIN, E. STAGG. Penal servitude. National Committee on Prison Labor, New York, 1912. Making roads through prison labor.
- WILLIAMS, S. M. Roads, their influence upon economic and social conditions. Garford Motor Truck Company, Lima, Ohio, 1915.
- WOOD, FRANCIS. Modern road construction. London, England, 1912. Chas. Griffin and Company, Exeter St., Strand.
- YOUNG, — Political and constitutional study of the Cumberland road.

STATE GEOLOGISTS

- Alabama Geological Survey, Dr. Eugene A. Smith, State geologist, University, Alabama.
- Arkansas Geological Survey, N. F. Drake, University of Arkansas, Fayetteville, Arkansas.
- California State Mining Bureau, F. McN. Hamilton, State mineralogist, San Francisco, California.
- Colorado Geological Survey, Prof. R. D. George, Boulder, Colorado.
- Connecticut Geological and Natural History Survey, Prof. William North Rice, superintendent, Middletown, Connecticut.
- Florida Geological Survey, Dr. E. H. Sellards, State geologist, Tallahassee, Florida.
- Georgia Geological Survey, Dr. S. W. McCallie, State geologist, Atlanta, Georgia.
- Illinois State Geological Survey, F. W. DeWolf, director, Urbana, Illinois.
- Indiana Department of Geology and Natural Resources, Edward Barrett, State geologist, Indianapolis, Indiana.
- Iowa Geological Survey, George F. Kay, State geologist, Iowa City, Iowa.
- Kansas State Geological Survey, Prof. Erasmus Haworth, State geologist, University of Kansas, Lawrence, Kansas.
- Kentucky Geological Survey, J. B. Hoeing, director, Frankfort, Kentucky.
- Louisiana Soil and Geological Survey, F. V. Emerson, Baton Rouge.
- Maryland Geological Survey, Prof. William B. Clark, State geologist, Johns Hopkins University, Baltimore, Md.
- Michigan Geological Survey, Roland C. Allen, director, 503 Hollister Block, Lansing, Michigan.
- Minnesota Geological Survey, William H. Emmons, State geologist, University of Minnesota, Minneapolis, Minnesota.
- Mississippi Geological Survey, Prof. E. N. Lowe, State geologist, Jackson, Mississippi.
- Missouri Bureau of Geology and Mines, Prof. H. A. Bushler, director, Rolla, Missouri.
- Montana Geological Survey, Dr. J. P. Rowe, State geologist, Missoula, Mont.
- Nebraska Geological Survey, Prof. E. H. Barbour, State geologist, University of Nebraska, Lincoln, Nebraska.
- New Jersey Geological Survey, Dr. H. B. Kummel, State geologist, Trenton, New Jersey.
- New Mexico, University of New Mexico, Prof. Charles T. Kirk, State geologist, Albuquerque, New Mexico.
- New York State Education Department, Sciences Division, Dr. John M. Clarke, Director and State geologist, State Museum, Albany, New York.
- North Carolina Geological and Economic Survey, Dr. Joseph Hyde Pratt, State geologist, Chapel Hill, North Carolina.
- North Dakota Geological Survey, Dr. A. G. Leonard, director, Grand Forks, North Dakota.
- Ohio Geological Survey, Prof. John A. Bownocker, State geologist, Columbus, Ohio.

Oklahoma Geological Survey, C. W. Shannon, director, Norman, Oklahoma.
Oregon, H. M. Parks, State geologist State Bureau of Mines and Geology.
Pennsylvania Geological and Topographical Commission, Prof. Richard
R. Rice, State geologist, Beaver, Pennsylvania.
Rhode Island Natural Resources Survey, Prof. Charles W. Brown, super-
intendent, Providence, Rhode Island.
South Carolina Geological Survey, Dr. Stephen Taber, State geologist,
Columbia, S. C.
South Dakota Department of Geology, Prof. Freeman Ward, State geolo-
gist, Vermillion, South Dakota.
Tennessee Geological Survey, Prof. A. H. Purdue, State geologist, Capitol
Annex, Nashville, Tennessee.
Texas Bureau of Economic Geology and Technology, Dr. J. A. Udden,
director, Austin, Texas.
Vermont Geological Survey, Prof. George H. Perkins, State geologist,
Burlington, Vermont.
Virginia Geological Survey, Dr. Thos. L. Watson, director, Charlottesville,
Virginia.
Washington Geological Survey, Prof. Henry Landes, State geologist, Uni-
versity Station, Seattle, Washington.
West Virginia Geological Survey, Prof. I. C. White, State geologist, Morgan-
town, West Virginia.
Wisconsin State Geological and Natural History Survey, Dr. E. A. Birge,
director and superintendent, W. O. Hotchkiss, State geologist, Mad-
ison, Wisconsin.
Wyoming Geological Survey, L. W. Trumbull, State geologist, Cheyenne,
Wyoming.

MANUFACTURERS

Manufacturers of Road Machinery and Equipment

(See also page 368)

- Abenague Machine Works** (rock drills), F. H. Greaney, manager, Boston, Massachusetts.
- Acme Equipment and Engineering Company**, J. Webb Saffold, secretary, Cleveland, Ohio.
- Acme Road Machinery Company**, W. A. Cook, president and general manager; James W. Jones, treasurer; David B. Cook, secretary, Frankfort, N. Y.
- Acme Wagon Company** (dump wagon), Emigsville, Pennsylvania.
- J. D. Adams and Company** (roader, grader and tractor), W. R. Adams, assistant manager, Indianapolis, Indiana.
- Albany Belting and Supply Company** (bitumen heater), Matthew Van Alstyne, president; A. Y. Van Alstyne, vice-president; William D. Baker, secretary; Charles H. Hay, treasurer.
- Allis-Chalmers Company** (gyratory crusher), Otto H. Falk, receiver; H. Schifflin, manager, crushing and cement machinery department, Milwaukee, Wisconsin.
- American Cement Machine Company, Inc.** The (mixer), 10 Johnson Street, Keokuk, Iowa.
- American Clay Machinery Company**, The (steam shovel), Bucyrus, Ohio.
- American Harrow Company**, Detroit, Michigan.
- American Process Company** (rock and sand dryers), 68 Williams Street, New York City.
- American Steel Scraper Company**, W. F. Kilborn, general manager, Sidney, Ohio.
- Ames Flow Company**, Oliver Ames, president; Frederick B. Hill, Boston, Massachusetts.
- Archer Iron Works** (concrete mixer, engines), 2400 34th Place, Chicago, Illinois.
- Armstrong Manufacturing Company**, Waterloo, Iowa.
- Atlas Engineering Company** (mixer), 700 Thirtieth Street, Milwaukee, Wisconsin.
- Auburn Wagon Company**, Lee Roy Myers, president; Max Robinson, treasurer and manager, Martinsburg, West Virginia.
- Austin-Western Road Machinery Company**, W. T. Beatty, president and general manager; W. I. Babb, vice-president and secretary; H. S. MacLay, treasurer; S. F. Beatty, assistant manager, Karpen Building, Chicago, Illinois.
- Badger Concrete Mixer and Machinery Company**, Watkins Building, Milwaukee, Wisconsin.
- Bain Wagon Company**, The, W. W. Strong, Kenosha, Wisconsin.
- A. D. Baker Company**, A. D. Baker, vice-president, Swanton, Ohio.
- Baker Manufacturing Company**, The (road graders), M. W. Baker, president, 337 W. Madison Street, Chicago, Illinois.
- Ball Engine Company** (steam shovel), Erie, Pennsylvania.
- Ballou Manufacturing Company** (concrete mixer), 124 High Street, Belding, Michigan.

- Bethlehem Steel Company, Charles M. Schwab, chairman Executive Committee, South Bethlehem, Pennsylvania.
- Bituminized Road Implement Company, Malden, Massachusetts.
- Blystone Machinery Company, Cambridge Springs, Pennsylvania.
- Bolte Manufacturing Company, The (mixer), Kearney, Nebraska.
- Browning Steam Shovel Company, The, main office and works, Mansfield, Ohio.
- Bucyrus Company (steam shovels), W. W. Coleman, president; E. K. Sargent, vice-president; G. A. Morison, secretary; D. P. Ellis, treasurer, South Milwaukee, Wisconsin.
- Buffalo Pitts Company (road tractors), F. G. Batchellor, sales manager, Buffalo, New York.
- Buffalo Steam Roller Company, J. F. Richardson, sales manager, Buffalo, New York.
- Bull Dog Dump Wagon Company, The, 205-206 Boston Building, Kansas City, Missouri.
- Burch Plow Works Company, The, J. L. Morrow, secretary, Crestline, Ohio.
- Butterworth and Lowe (concrete mixer), 17 Huron Street, Grand Rapids, Michigan.
- Call-Watt Company, The (road graders), Richmond, Virginia.
- Canton Culvert Company, Julius H. Schlafly, president; Perry Van Horne, secretary, treasurer and general manager; Chas. Haines, vice-president and superintendent, Canton, Ohio.
- Case Plow Works, J. I. (road plows and tractors), Racine, Wisconsin.
- J. I. Case Threshing Machine Company, Frank K. Bull, president; F. Lee Norton, vice-president; Warren J. Davis, treasurer; Richards T. Robinson, secretary; W. W. Ramsey, general sales manager, Racine, Racine County, Wisconsin.
- Cement Tile Machinery Company, The (concrete mixer), W. H. Stewart, Secretary, Waterloo, Iowa.
- C. H. & E. Manufacturing Company, Inc. (gasoline engines and contractors' pumps), F. F. Hase, secretary and treasurer, Milwaukee, Wisconsin.
- Chain Belt Company (concrete mixers), C. W. Levalley, president; Wm. C. Sargent, vice-president and secretary; Wm. C. Frye, treasurer, Milwaukee, Wisconsin.
- Chamberlain Road Machine Company (graders, tractors and drags), Hutchinson, Minnesota.
- Chicago Pneumatic Tool Company, George A. Rees, general manager, Fisher Building, Chicago, Illinois.
- Cleveland Pneumatic Tool Company, The, Cleveland, Ohio.
- Climax Road Machine Company, J. R. Manning, president; S. Jones Philips, vice-president; T. R. Clark, secretary-treasurer, Marathon, New York.
- Columbia Wagon Company, W. T. Garrison, president; H. F. Yergey, treasurer and manager; Edward B. Smith, secretary, Columbia, Pennsylvania.
- Concrete Form and Engine Company, 503 Wayne County Bank Building, Detroit, Michigan.
- Connery & Company, Inc. (dryers, heaters, road sprayers), Second and Luzerne Streets, Philadelphia, Pennsylvania.
- Cropp Concrete Machinery Company (concrete mixer), 118 N. La Salle Street, Chicago, Illinois.
- Dauch Manufacturing Company (tractors), J. J. Dauch, president, Sandusky, Ohio.
- Deere and Company (road plow), Moline, Illinois.

- Denning Motor Implement Company, The (tractor), J. M. Denning, president, Cedar Rapids, Iowa.
- Disc Grader and Plow Company, Allen L. Powlinson, president, Minneapolis, Minnesota.
- Eagle Wagon Works, Frank E. Swift, president; Thomas M. Osborne, vice-president; Courtney C. Avery, secretary; Clarence F. Baldwin, treasurer, Auburn, New York.
- East Iron and Machine Company, The (portable asphalt paving plant), Lima, Ohio.
- Elite Manufacturing Company (concrete mixer), E. L. Kilhefner, Ashland, Ohio.
- Emerson-Brantingham Company, successors to The Geiser Manufacturing Company (road rollers), Waynesboro, Pennsylvania.
- Enterprise Manufacturing Company (road roller), Columbiana, Ohio.
- Erie Machine Company, The, P. W. Dietley, manager, Erie, Pennsylvania.
- E. D. Etnyre and Company (road sprinklers), Oregon, Illinois.
- Eureka Machine Company, Inc. (mixers), Lansing, Michigan.
- Everett Manufacturing Company (dumping boxes), 48 Lake Street, Newark, New Jersey.
- Fairbanks, Morse and Company (tractors), Wabash Avenue and Eldredge Place, Chicago, Illinois.
- Fairbanks Steam Shovel Company, Marion, Ohio.
- A. B. Farquhar Company, Ltd. (engines), York, Pennsylvania.
- Finley, Sam E. (oil distributor), Candler Building, Atlanta, Georgia.
- Flinchbaugh Manufacturing Company (road roller), Greencastle, Pennsylvania.
- Foots Manufacturing Company (concrete mixer), Nunda, New York.
- Francis Machinery Company, 4 Market Street, St. Louis, Missouri.
- Frick Company, Inc. (engines), A. O. Frick, president; Esra Frick, vice-president and general manager; W. H. Manns, secretary; D. Norris Benedict, treasurer.
- "Friend" Manufacturing Company, Casport, New York.
- Galion Iron Works Company, David C. Boyd, president; G. L. Stiefel, vice-president; B. T. Moyer, secretary; F. W. Faber, treasurer, Galion, Ohio.
- Gardner Crusher Company, Ed. E. Gauche, treasurer, 556 W. 34th Street, New York, New York.
- Girnau Manufacturing Company, 121 South River Street, Eau Claire, Wisconsin.
- Glen Wagon and Car Corporation, Cortland, New York.
- Glen Wagon Works, Harry Glen, manager, Seneca Falls, New York.
- Glide Road Machine Company, Clyde Waterman, president, Minneapolis, Minnesota.
- Globe Machinery and Supply Company (road drags), Des Moines, Iowa.
- Good Roads Machinery Company, Kennett Square, Pennsylvania.
- Graves-Spears Road Machinery Company, D. E. Graves, vice-president, Oakland, California.
- Griffith Iron Works Company, George Griffith, Jr., president, St. Louis, Missouri.
- Guelich Paving Company, The (street paving machine), Otto E. Guelich, president, 1412 Great Northern Building, Chicago, Illinois.
- Gunn's Road Builder (grader), D. B. Gunn, Red Oak, Iowa.
- Haies Manufacturing Company, George (unloader), New York City.
- Hall-Holmes Manufacturing Company (gasoline engine), 280 Oak Street, Jackson, Michigan.
- Hanna Manufacturing Company, The (engineering instruments), Troy, New York.

- Hart-Parr Company, The (tractor), C. W. Hart, president, Charles City, Iowa.
- Haywood Wagon Company, John W. Haywood, general manager, Newark, New York.
- Heider Manufacturing Company, Carroll, Iowa.
- Hetherington and Berner (asphalt paving plants), Indianapolis, Indiana.
- Hobbs Concrete Machinery Company, The, N. F. Hobbs, sales-manager, Detroit, Michigan.
- Holt Manufacturing Company (caterpillar engine), Peoria, Illinois.
- Huber Manufacturing Company (road roller), S. E. Barlow, president and general manager; F. A. Huber, vice-president; E. C. L. Barlow, treasurer; E. Durfee, secretary, Marion, Ohio.
- Humboldt Manufacturing Company (testing apparatus), 2014 Nebraska Avenue, Chicago, Illinois.
- Hvass and Company, Chas., (road machinery), B. Chas. Hvass, Wm. B. Lorenzo, 509-11 East 18th Street, New York City.
- Hydrex Felt and Engineering Company, The (bituminous expansion joints), 120 Liberty Street, New York City.
- Ideal Concrete Machinery Company, M. Wetsstein, president and treasurer; G. B. Pulfer, vice-president and general manager; G. B. Hopkins, secretary, South Bend, Indiana.
- Imperial Machinery Company, Inc. (tractor), 1611 Central Avenue, Minneapolis, Minnesota.
- Indiana Road Machine Company, Jno. M. Landenberger, president and treasurer; Chas. Stockman, Jr., secretary, Fort Wayne, Indiana.
- Ingersoll-Rand Company (rock drills), W. L. Saunders, president; George Doubleday, vice-president; W. R. Grace, vice-president and treasurer; George R. Elder, vice-president; J. S. Phipps, vice-president; F. A. Brainard, secretary, 11 Broadway, New York City.
- International Harvester Company of America (tractors), Harvester Building, Chicago, Illinois.
- International Instrument Company, Arthur Kendrick, treasurer, 23 Church Street, Cambridge, Massachusetts.
- Iroquois Iron Works, Arthur W. Sewall, president; A. D. Andrews, vice-president; Ira Atkinson, treasurer, Buffalo, New York.
- Jaeger Machine Company (concrete mixer), Columbus, Ohio.
- Jeffery Manufacturing Company, East First Avenue, Columbus, Ohio.
- The Kelly Manufacturing Company (road drags), Waterloo, Iowa.
- Kelly-Springfield Road Roller Company, Chas. M. Greiner, president, Springfield, Ohio.
- Kent Machine Company, The, M. L. Garrison, president; W. S. Kent, vice-president; F. H. Merrell, secretary-treasurer, Kent, Ohio.
- Kent Mill Company (rock crusher), 10 Rapelyea Street, Brooklyn, New York.
- Kentucky Wagon Manufacturing Company (dump wagons), Louisville, Kentucky.
- Kilbourne and Jacobs Manufacturing Company, The (scrapers and wheelbarrows), Columbus, Ohio.
- Kindling Machinery Company, The (street sweeper), H. Buchenberger, general manager, Milwaukee, Wisconsin.
- Kinnard-Haines Company (gasoline tractor), O. B. Kinnard, 367 44th Avenue, Minneapolis, Minnesota.
- Kinney Manufacturing Company (auto heater and distributor), J. Royal Kinney, president, 100 Boylston Street, Boston, Massachusetts.
- Knickerbocker Company, The (mixers), W. B. Knickerbocker, Jackson, Michigan.

- Koehring Machine Company, Wm. J. Koehring, president; Richard Keil, vice-president; P. Koehring, secretary-treasurer, 615-17 Germania Building, Milwaukee, Wisconsin.
- Kolesch and Company, Inc. (surveyors' instruments), Emilie Kolesch, president; Percy A. Kolesch, treasurer, 138 Fulton Street, New York City.
- Lansing Company, formerly Lansing Wheelbarrow Company (concrete mixers, etc.), E. W. Sparrow, president; F. Thoman, vice-president; A. C. Stebbins, secretary and general manager; H. E. Moore, treasurer. Lansing, Michigan.
- Lawrence Pump and Engine Company, Lawrence, Massachusetts.
- Lee Loader Company (wagon loaders), 824 W. 36th Street, Chicago, Illinois.
- Lehigh Foundry Company, The (road scarifiers), Fullerton, Pennsylvania.
- Linder Grader Company, Paul C. Linder, Matthews, Indiana.
- Link-Belt Company, Inc. (hoisting cranes), James M. Dodge, chairman; Charles Pies, president and treasurer; Glenn G. Howe, vice-president, Chicago, Illinois.
- Littleford Brothers (tar heaters), 448 E. Pearl Street, Cincinnati, Ohio.
- Matchless Street Cleaner Company, The, Troy, New York.
- McHarg and Company, E. J. (concrete mixers), E. J. McHarg, L. R. McHarg, 3 Crandall Street, Binghamton, New York.
- McKiernan-Terry Drill Company (rock drill), 117 Broadway, New York, New York.
- McNutt Lewis (clay, sewer, block and pipe), 14 South Walnut Street, Brazil, Indiana.
- Lourie Manufacturing Company, Springfield, Illinois.
- Marion-Osgood Company (traction shovels), 51 State Street, Albany, New York.
- Marion Steam Shovel Company, Geo. W. King, president and general manager; Frank A. Huber, vice-president and treasurer; R. H. Reidenbaugh, secretary, Marion, Ohio.
- Marsh-Capron Manufacturing Company (concrete mixers), H. M. Capron, secretary, Old Colony Building, Chicago, Illinois.
- Mayer Brothers Company, Mankato, Minnesota.
- Mercury Manufacturing Company, The, Chicago, Illinois.
- Milburn Wagon Company, H. W. Suydam, president, Toledo, Ohio.
- Milwaukee Concrete Mixer and Machinery Company, A. G. Bodden, secretary-treasurer, Milwaukee, Wisconsin.
- Minneapolis Steel and Machinery Company (road tractor), Minneapolis, Minnesota.
- Monarch Road Roller Company, Nat Tyler, Jr., president, Groton, New York.
- N. S. Monroe and Sons (Monroe road machine), Arthur, Illinois.
- Morse Twist Drill and Machine Company, New Bedford, Massachusetts.
- Thomas Moulding Company, T. C. Moulding, Chicago, Illinois.
- Municipal Engineering and Contracting Company (concrete mixers), F. C. Austin, president, 607-11 Railway Exchange Building, Chicago, Illinois.
- Munnsville Plow Company, J. E. Sperry, president, Munnsville, New York.
- New Holland Machine Company, P. S. Hess, secretary, New Holland, Pennsylvania.
- "New-Way" Motor Company, The, E. W. Goodnow, secretary, Lansing, Michigan.
- New Way Paving Corporation, The (street cleaners), Woolworth Building, New York.

- Nims Concrete Machinery (concrete mixer), Philadelphia, New York.
- Northwestern Steel and Iron Works (mixer), Thomas W. Resholt, vice-president, Eau Claire, Wisconsin.
- Novo Engine Company, C. E. Bement, secretary and manager, Lansing, Michigan.
- Ohio Ceramic Engineering Company (concrete mixers), Cleveland, Ohio.
- Ohio Manufacturing Company, The, A. B. Whitney, president and treasurer; W. E. Robinson, vice-president; Chas. C. Kouns, secretary, Upper Sandusky, Ohio.
- Ohio Road Machinery Company, The, W. A. Heusner, president; D. E. Graves, vice-president; C. H. Dudley, secretary-treasurer, Oberlin, Ohio.
- Ohio Tractor-Roller Sales Company (tractor), W. W. Williams, president, 507-11 Brunson Building, Columbus, Ohio.
- Oliver Chilled Plow Works, South Bend, Indiana.
- Oliver Manufacturing Company, The Wm. J. (dump and spreader cars). Knoxville, Tennessee.
- Orenstein-Arthur Koppel Company (dump cars), 30 Church Street, New York, New York.
- Original Gas Engine Company, The, R. E. Olds, president; C. S. Smith, sales manager, Lansing, Michigan.
- Oshkosh Manufacturing Company (concrete mixer), Oshkosh, Wisconsin.
- Otto Gas Engine Works, 3411 Walnut Street, Philadelphia, Pennsylvania.
- Overturf Mold and Mixer Company (mixers and culvert molds), Dumont, Iowa.
- Owensboro Ditcher and Grader Company, W. R. Williams, sales-manager, Owensboro, Kentucky.
- Pennsylvania Crusher Company, Stephen Girard Building, Philadelphia, Pennsylvania.
- Peoria Metal Culvert Company (road finisher), East Peoria, Illinois.
- Petrolithic Company, The, Los Angeles, California.
- Pioneer Tractor Manufacturing Company, Winona, Minnesota.
- Port Huron Engine and Thresher Company, C. F. Harrington, president; H. L. Stevens, vice-president; A. E. West, general manager; D. C. Kinch, secretary; J. T. Sullivan, treasurer, Port Huron, Michigan.
- Power Mining Machinery Company, 115 Broadway, New York, New York.
- Quenner Company, The (stone crusher), Mitts Quenner, president, 908 South Olive Street, Los Angeles, California.
- Quincy Engine Company, I. C. Walk, general manager, Quincy, Pennsylvania.
- Raber and Lang Manufacturing Company (mixers), 202 Mill Street, Kendallville, Indiana.
- Ransome Concrete Machinery Company, A. W. Ransome, Dunellen, New Jersey.
- Rapid Mixer Company, 84 Porter Block, Grand Rapids, Michigan.
- Revolute Machine Company (blue printing machine), J. V. McAdam, president; C. J. Everett, treasurer; R. B. Snow, sales manager, 417 East 93d Street, New York City.
- Roughen, P. (adjustable street gauge), 213 Amory Street, Fond du Lac, Wisconsin.
- Ruggles-Coles Engineering Company, Wm. B. Ruggles, president; Robt. G. McGann, vice-president; Lindsay R. Christie, secretary-treasurer, 50 Church Street, New York City.
- Rumely Products Company (tractors), Clarence S. Funk, president, Michigan Boulevard Building, Chicago, Illinois.
- Rural Road Machinery Company, The (road grader). Albert Akers, president, Quincy, Illinois.

- Russell Company, The, J. W. McClymonds, president; C. M. Russell, vice-president; E. C. Merwin, second vice-president and secretary; Geo. H. McCall, treasurer, Massillon, Ohio.
- Russell Grader Manufacturing Company, E. E. Ellerston, president and manager; C. O. Wold, secretary-treasurer, Minneapolis, Minnesota.
- Sanitary Street Flushing Machine Company, W. R. Anders, secretary, St. Louis, Missouri.
- Schaefer Manufacturing Company, The (concrete mixers), Park and Main Streets, Berlin, Wisconsin.
- Shunk Plow Company, Bucyrus, Ohio.
- Sidney Steel Scraper Company, The, William A. Perry, president, Sidney, Ohio.
- Skow Manufacturing Company (road machinery), Newton, Iowa.
- A. F. Smith Company, P. A. Smith, New Brighton, Pennsylvania.
- T. L. Smith Company (concrete mixer), T. L. Smith, president; C. F. Smith, vice-president; W. J. Buckley, secretary-treasurer, 1304 Majestic Building, Milwaukee, Wisconsin.
- Smith and Sons Manufacturing Company, William J. Smith, president; Kansas City, Missouri.
- Southern Branch Petrolithic Company, New Orleans, Louisiana.
- Spray Nozzle Company, George S. Crittenden, general manager, 205 Devonshire Street, Boston, Massachusetts.
- R. H. Staley (tamping machines), Box 229, Springfield, Illinois.
- Standard Manufacturing Company, Pliny E. Bassett, proprietor, Worcester, Massachusetts.
- Standard Scale and Supply Company (concrete mixer), John C. Reed, president, 243 Water Street, Pittsburgh, Pennsylvania.
- Sternberg Motor Truck Company (road truck), Victor L. Brown, vice-president, Milwaukee, Wisconsin.
- Stockland Road Machinery Company, A. G. Dunlop, president and treasurer, Minneapolis, Minnesota.
- Studebaker Corporation (road machinery), Albert R. Erskine, president; Clement Studebaker, Jr., general manager; Geo. M. Studebaker, treasurer; A. R. Erskine, secretary, South Bend, Indiana.
- Sturtevant Mill Company (generators), Thos. L. Sturtevant, president; Clayton and Park Streets, Boston, Massachusetts.
- Sullivan Machinery Company (rock drills), F. K. Copeland, president; J. Duncan Upham, treasurer; Albert Ball, mechanical engineer; Thos. W. Fry, secretary, 150 Michigan Avenue, Chicago, Ill.
- Syracuse Chilled Plow Company, Carlton A. Chase, president and treasurer; Wm. W. Ward, vice-president and secretary, Syracuse, New York.
- Tarrant Manufacturing Company (road oiling appliances), W. P. Tarrant, president; W. R. Wilson, treasurer, Saratoga Springs, New York.
- Taylor Road Inventions and Manufacturing Company, Denver, Colorado.
- Thew Automatic Shovel Company, The, F. A. Smith, president; R. Thew, vice-president and general manager; E. M. Pierce, treasurer, Lorain, Ohio.
- Tiffin Wagon Company, The, W. S. Shelly, manager, Tiffin, Ohio.
- Tinius Olsen Testing Machine Company, Philadelphia, Pennsylvania.
- Traylor Engineering and Manufacturing Company (gyratory crushers), 30 Church Street, New York City.
- Trautwein Dryer and Engineering Company, 417 South Dearborn Street, Chicago, Illinois.
- Troy Wagon Works Company, The, Troy, Ohio.
- Twentieth Century Mixer Company, Norwood, Ohio.
- Universal Crusher Company, 303 North 3d Street, Cedar Rapids, Iowa.
- Union Iron Works, Lackawanna Siding, Hoboken, New Jersey.
- Universal Road Machinery Company, R. E. Leighton, general manager, Kingston, New York.

U. S. Standard Manufacturing Company (concrete mixer), C. H. Snyder, secretary, Ashland, Ohio.
 Utica Pipe and Foundry Company, Utica, New York.
 Van Dusen-Roys Company (concrete mixer), Frank Van Dusen, president, Columbus, Ohio.
 Van Noubuys Machine Works (pumps), 41 Liberty Street, Albany, New York.
 Virginia Bridge and Iron Company, C. Edwin Michael, president; T. T. Fishburne, vice-president and treasurer; Jno. R. Parker, secretary, Roanoke, Virginia.
 Wallis Tractor Company, H. M. Wallis, Jr., secretary, Cleveland, Ohio.
 Waterloo Cement Machinery Corporation (mixers, hoists and contractors equipment) Waterloo, Iowa.
 Watson Wagon Company, A. A. Keesler, president; C. M. Grouse, vice-president; Levi S. Chapman, secretary-treasurer, Canastota, New York.
 Western Wheeled Scraper Company, W. I. Babb, president; W. D. Foulke, treasurer; Frank C. Worthington, secretary, Aurora, Illinois.
 Wheeling Mold and Foundry Company (rock crusher), Leroy A. Kling, sales manager, Wheeling, West Virginia.
 White Company, The (road truck), Windsor T. White, president, Cleveland, Ohio.
 Whitman Agricultural Company, H. L. Whitman, 6930 South Broadway, St. Louis, Missouri.
 Wiard Plow Company, Arthur G. Hough, president, Batavia, New York.
 Wichita Concrete Machinery Company, 232 N. Santa Fe Avenue, Wichita, Kansas.
 Wood Drill Works, Paterson, New Jersey.
 The F. B. Zieg Manufacturing Company (culverts), Fredericktown, Ohio.

Manufacturers of Road Material and Engineering Equipment

(See also page 261)

Ainsworth and Sons, Wm. (engineering instruments), Denver, Colorado.
 Alcott, Edward (white oak key and wood block), Manassas, Virginia.
 Alden Speare's Sons Company (road oils), Boston, Massachusetts.
 American Bridge Company of New York, George L. Denio, chief clerk, Hudson Terminal, 30 Church Street, New York City.
 American Casting Company (culverts), D. B. Dimick, president, Birmingham, Alabama.
 American Cast Iron Pipe Company, Birmingham, Alabama.
 American Drafting Furniture Company, F. W. Barkley, vice-president, Rochester, New York.
 American Granite Company, Otto Rathman, president, Milwaukee, Wisconsin.
 American Paving and Manufacturing Company, Indianapolis, Indiana.
 American Rolling Mill Company (culvert iron), Middletown, Ohio.
 American Steel and Wire Company (steel reinforcement), 72 West Adams Street, Chicago, Illinois.
 American Tar Products, S. H. Bingham, president, 208 South LaSalle Street, Chicago, Illinois.
 Amies Asphalt Company, Dr. Joseph H. Amies, 1520 Chestnut Street, Philadelphia, Pennsylvania.
 Amies Road Company, John Rice, president; W. T. Newcomb, engineer, Drake Building, Easton, Pennsylvania.
 American Sheet and Tin Plate Company (culverts), H. V. Jamison, manager, Pittsburgh, Pennsylvania.

- American Tar Company, Charles P. Price, manager; road department, 201 Devonshire Street, Boston, Mass.
- Arnott, Lee (culvert pipe), 518 Little Building, Lincoln, Nebraska.
- Asphalt Block and Pavement Company (blocks and tiles), Ohio Building, Toledo, Ohio.
- Atlanta Gas Light Company, R. C. Congdon, manager, Electric and Gas Building, Atlanta, Georgia.
- Atlantic Bitulithic Company, George O. Tenney, president, Richmond, Virginia.
- Atlantic Refining Company, The, J. W. Van Dyke, president; W. P. Cutler, vice-president; W. M. Irish, secretary, and Henry S. Mustin, treasurer, 3144 Passyunk Avenue, Philadelphia, Pa.
- Atlantic Westrumite Company, Inc., J. H. Cranford, president; R. Y. Filbert, vice-president; A. H. Putnam, secretary and treasurer, 2620 E Street N.W., Washington, D. C.
- Attica Bridge Company, Attica, Indiana.
- Austin Brothers (bridges, machinery), Dallas, Texas, and Atlanta, Georgia.
- R. D. Baker Company (expansion joints), R. D. Baker, president, 73 Home Bank Building, Detroit, Michigan.
- Barber Asphalt Paving Company, Charles W. Bayliss, manager road department, Land Title Building, Philadelphia, Pennsylvania.
- Barrett Manufacturing Company, F. S. Hutchinson, manager Tarvia department, 17 Battery Place, New York, New York.
- Bausch and Lomb Optical Company (instruments), Rochester, New York.
- Baker and Lockwood Manufacturing Company (tents), Kansas City, Missouri.
- L. Beckmann Company, The (surveyors' instruments), 600 Adams Street, Toledo, Ohio.
- Beecher Draft Spring Company, New Haven, Connecticut.
- C. L. Berger and Sons (surveyors' instruments), 37 Williams Street, Boston, Massachusetts.
- Binder Company, The (road oils), John H. Hurlbutt, president, 82 Beaver Street, New York, New York.
- Birdsboro Stone Company, Chas. A. Bergdoll, president; Robt. MacBurney, general manager; E. C. Bergdoll, treasurer; Albert T. Hall, secretary, 614 Bulletin Building, Philadelphia, Pennsylvania.
- Birmingham Rail and Locomotive Company (locomotives and steam shovels), Birmingham, Alabama.
- Bituminised Road Company (pavement manufacturer), Reliance Building, Kansas City, Missouri.
- Bituminous Products Company ("Besco" expansion joint), 378 Woodward Avenue, Detroit, Michigan.
- Rudolph S. Blome Company (paving block), Rudolph S. Blome, president; City Hall Square Building, Chicago, Illinois.
- Braden Culvert Company, Terre Haute, Indiana.
- F. E. Brandis Sons Company (surveyors' instruments), 610-614 Gates Avenue, Brooklyn, New York.
- British American Oil Company, Ltd., The, S. R. Parsons, president, Toronto, Ontario, Canada.
- Buff and Buff Manufacturing Company (surveyors' instruments), Jamaica Plains, Massachusetts.
- Edward E. Buhler Company (supplies), Edward E. Buhler, president and general manager, 103 Park Avenue, New York City.
- Burton Powder Company, J. Burton, president, Pittsburgh, Pennsylvania.
- Butler Manufacturing Company (culverts), Chas. R. Butler, president; John D. Stevens, secretary and treasurer; E. E. Norquist, superintendent, Minneapolis, Minnesota.

- Byerley and Sons (road oils), Frank A. Byerley, Cleveland, Ohio.
- Cannelton Sewer Pipe Company, H. H. Clemens, secretary, Cannelton, Indiana.
- Philip Carey Company, The (expansion joints), George D. Crabbs, president; R. B. Crabbs, vice-president; E. L. Buse, secretary, Cincinnati, Ohio.
- Carnegie Steel Company (crushed slag and bridge steel), Pittsburgh, Pennsylvania.
- Champion Bridge Company, Wilmington, Ohio.
- Chattanooga Sewer Pipe and Fire Brick Company (culverts), O. E. Deppen, vice-president, Chattanooga, Tennessee.
- Chicago Steel Tape Company, L. A. Nichols, president, 6229-6233 Cottage Grove Avenue, Chicago, Illinois.
- Clip-Bar Manufacturing Company (curb guard), Philadelphia, Pennsylvania.
- Clow and Sons, J. B. (cast iron culvert pipe), Chicago, Illinois.
- Coast Culvert and Flume Company, James S. Beall, Portland, Oregon.
- Concrete Guard Rail Company, J. Y. McClintock, manager, Rochester, New York.
- Conneaut Shovel Company, The, G. W. Benton, secretary, Conneaut, Ohio.
- Consolidated Metal Expanded Company (reinforcement bars), Park Avenue and 40th Street, New York City.
- Continental Bitumen Company, The, Toledo, Ohio.
- Continental Bridge Company, Chicago, Illinois.
- Corrugated Bar Company, Mutual Life Building, Buffalo, New York.
- Craig Oil Company, The, 316 Gardner Building, Toledo, Ohio.
- Crescoted Wood Block Paving Company, R. S. Manley, president, New Orleans, Louisiana.
- Cummer and Sons Company, F. D., Cleveland, Ohio.
- Cyclone Drill Company, Orrville, Ohio.
- Detroit Graphite Company (bridge paint), 10 Twelfth Street, Detroit, Michigan.
- Dickey Clay Manufacturing Company, W. S. (culverts), Walter S. Dickey, president, 200 New York Life Building, Kansas City, Missouri.
- Dietzgen Company, Eugene (surveyor's instruments), 214-220 East 23d Street, New York City.
- Dixie Culvert and Metal Company, H. P. Smith, vice-president; Atlanta, Georgia.
- Donaldson Iron Company, Emaus, Pennsylvania.
- du Pont de Nemours Powder Company, E. I., Wilmington, Delaware.
- Dustoline for Roads Company, The, Jno. S. Lamson, Jr., president; Edwin R. Lamson, vice-president; W. J. Lamson, treasurer; Fred L. LaRowe, secretary, Summit, New Jersey.
- Equitable Asphalt Maintenance Company, The, F. H. Moore, secretary-treasurer, Commerce Building, Kansas City, Missouri.
- Farnsworth Company, C. L. (engineering instruments), 23 Central Street, Boston, Massachusetts.
- Farris Bridge Company, William Farris, president, Jenkins Arcade Building, Pittsburgh, Pennsylvania.
- Filer Company, W. H. (sign boards), 337 Jackson Street, Grove City, Pennsylvania.
- Fort Dodge Culvert Company, Sioux City, Iowa.
- France Stone Company, The, L. H. Hawblitz, Ohio Building, Toledo, Ohio.
- Frey and Company, Louis (surveyors' instruments), A. H. Honaker, manager, 116 Williams Street, New York, New York.
- Fibred-Asphalt Company, George A. Henderson, St. Albans, West Virginia.
- Fulcher Concrete Block and Paving Company, D. G. Donahue, secretary, Oakland, California.

Gafford Culvert and Machinery Company, The, San Antonio, Texas.
 Gilsonite Construction Company, 721 Wainwright Building, St. Louis, Missouri.
 Glamorgan Pipe and Foundry Company (cast iron culvert pipe), Lynchburg, Virginia.
 Glidden Varnish Company, The (concrete paints), Cleveland, Ohio.
 Greenberg Iron Company, A. L. (culverts), C. V. Joseph, manager sales department, Terre Haute, Indiana.
 Gurley, W. and L. E. (surveyors' instruments), Troy, New York.
 O. K. Harry Steel Company, 2340-42 Papin Street, St. Louis, Missouri.
 Hartford Paving and Construction Company (culverts), Hartford, Connecticut.
 Hastings Pavement Company, The, E. J. Morrison, president and general manager; O. A. Palmer, treasurer; C. P. Pultz, secretary, 25 Broad Street, Broad-Exchange Building, New York, New York.
 Hassam Paving Company, Matthew J. Whittall, president; Harold Parker, vice-president; Alfred Thomas, treasurer; Walter E. Hassam, general manager, Slater Building, Worcester, Massachusetts.
 Headley Good Roads Company (road oils), W. T. Headley, president; 30th and Spruce Streets, Philadelphia, Pennsylvania.
 Hennepin Bridge Company, The, Minneapolis, Minnesota.
 Higgins and Company, Charles M. (copying ink), Brooklyn, New York.
 Highway Culvert Form Company, The, 100-102 Madison Street, Ottawa, Illinois.
 Hotchkiss Lock Metal Form Company, M. S. Hotchkiss, president, Binghamton, New York.
 Huasteca Petroleum Company, A. R. Knight, sales manager, Whitney Bank Building, New Orleans, Louisiana.
 Illinois Bridge Company, H. E. Williams, president, 1629 Monadnock Block, Chicago, Illinois.
 Independent Powder Company of Missouri, N. P. Rood, president, Joplin, Missouri.
 Indestructible Sign Company, The, Columbus, Ohio.
 Inland Steel Company (culverts), George H. Jones, secretary, First National Bank Building, Chicago, Illinois.
 International Asphalt Company, Chamber of Commerce Building, Chicago, Illinois.
 Jefferson Powder Company, Atlanta, Georgia.
 Jennison-Wright Company, Toledo, Ohio.
 Kalamasoo Foundry and Machine Company (culverts), Kalamasoo, Michigan.
 Keystone National Powder Company, Emporium, Pennsylvania.
 Keuffel and Esser (surveyors' instruments), Hoboken, New Jersey.
 Klauer Manufacturing Company (culverts), W. H. Klauer, secretary, 110 South Dearborn Street, Chicago, Illinois.
 Ledder and Probst (surveyors' instruments), Boston, Massachusetts.
 Lewis Manufacturing Company, F. J. (road oils), 2500 South Robey Street, Chicago, Illinois.
 Lufkin Rule Company, The, A. M. Marshall, president, Saginaw, Michigan.
 Luten, Daniel B. (concrete bridges), Indianapolis, Indiana.
 Lynchburg Foundry Company (cast iron culvert pipe), Lynchburg, Virginia.
 Marsh Engineering Company (bridge builders), Des Moines, Iowa.
 Massillon Iron and Steel Company, Massillon, Ohio.
 Memphis Bridge Company, Memphis, Tennessee.
 Memphis Stone and Gravel Company, Memphis, Tennessee.
 Merrilat Culvert Core Company (culvert forms), C. C. Merrilat, general manager, Winfield, Iowa.

- Mexican Petroleum Company, Ltd., Edward L. Doheny, president, 52 Broadway, New York City.
- Michigan Bridge and Pipe Company, Lansing, Michigan.
- Midland Bridge Company, The, 504-510 Midland Building, Kansas City, Missouri.
- Morrison Tent and Awning Company, 115-17 Olive Street, St. Louis, Missouri.
- National Concrete Company, 805 Traction Terminal Building, Indianapolis, Indiana.
- National Pavement Company of New York, 30 Church Street, New York City.
- National Tracing Cloth Company, Saylesville, Rhode Island.
- National Tube Company, Wm. B. Schiller, president, Pittsburgh, Pennsylvania.
- Neuchatel Asphalt Company, Ltd., The, C. Pollard Urquhart, manager, 79 Tompkins Street, New York City.
- Newport Culvert Company, The (metal culverts), Newport, Kentucky.
- Newport Rolling Mill Company, Frank A. Moesch, sales manager, Newport, Kentucky.
- Northfield Iron Company, 422 Water Street, Northfield, Minnesota.
- North Western Expanded Metal Company (reinforcement bars), Old Colony Building, Chicago, Illinois.
- Oregonia Bridge Company, The, Thomas R. Spencer, president, Lebanon, Ohio.
- Pennsylvania Steel Company, The, Morris Building, 1421 Chestnut Street, Philadelphia, Pennsylvania.
- Pennsylvania Trojan Powder Company, Allentown, Pennsylvania.
- Pioneer Asphalt Company, H. B. Pullar, general manager, Lawrenceville, Illinois.
- Portsmouth Culvert Company, N. J. Ewing, president, Portsmouth, Ohio.
- Prudential Oil Corporation, R. W. Sanders, sales manager, 17 Battery Place, New York City.
- Quick Unloading Car Chute Company, 807 Title Building, Birmingham, Alabama.
- Republic Creosoting Company, P. C. Reilly, Indianapolis, Indiana.
- Roanoke Bridge Company, Inc., Roanoke, Virginia.
- Robeson Process Company, J. S. Robeson, president, 18 East 41st Street, New York City.
- Rock Island Bridge and Iron Works, Rock Island, Illinois.
- Roemac Road Corporation (road binder), 860 Leader-News Building, Cleveland, Ohio.
- Ruehle, E. G. (surveyors' instruments), 119 Fulton Street, New York City.
- Salfisberg, J. E. and Company (engineering instruments), Aurora, Illinois.
- San Antonio Sewer Pipe Works, San Antonio, Texas.
- Seelig and Sons, R. (engineering instruments), 320 North Fifth Avenue, Chicago, Illinois.
- Shannon Self-Locking Metal Culvert, The, George G. McGlaughlin, Cincinnati, Ohio.
- Shelby Downward Asphalt Company, Ardmore, Oklahoma.
- Sicilian Asphalt Paving Company, Howard Carroll, president; Harry Haggerty, secretary; George C. Clausen, treasurer, 41 Park Row and 12th Avenue and 54th Street, New York City.
- Soltman, E. G. (surveyors' instruments), 134 West 29th street, New York City.
- Semet-Solvay Company, Fredk. R. Hazard, president; Rowland G. Hazard, vice-president; L. O. MacDaniel, treasurer; Geo. E. Francis, secretary, Syracuse, New York.

- Southern Sewer Pipe Company, J. A. Millson, manager, Birmingham, Alabama.
- Southern Wood Preserving Company, R. H. White, president, Atlanta, Georgia.
- Standard Asphalt and Rubber Company, E. G. Leszynsky, president. 208 South LaSalle Street. Chicago, Illinois.
- Standard Cast Iron Pipe Company, Bristol, Pennsylvania.
- Standard Oil Company of New Jersey, 26 Broadway, New York City.
- Standard Oil Company of New York, 26 Broadway, New York City.
- Stanford-Crowell Company (sign boards), W. H. Crowell, president, Ithaca, New York.
- Stark, N. M., and Company (bridge builders), Des Moines, Iowa.
- Steel Protected Concrete Company, H. A. Miner, president, Real Estate Trust Building, Philadelphia, Pennsylvania.
- Sun Company, J. N. Pew, Jr., president, 1421 Chestnut Street, Morris Building, Philadelphia, Pennsylvania.
- Sweeney and Gray (road supplies), J. A. Gray, manager, 61 Sixth Street, Long Island City, New York.
- Thomas Steel Reinforcement Company (reinforcing bars), Majestic Building, Detroit, Michigan.
- Traub and Helfrecht (culvert), Germania, Pennsylvania.
- Tennessee Metal Culvert Company, L. G. Boxwell, secretary, Nashville, Tennessee.
- Texarkana Pipe Works (culverts), Texarkana, U. S. A.
- Trussed Concrete Steel Company, Detroit, Michigan.
- Universal Drafting Machine Company, Cleveland, Ohio.
- Union Clay Products Company (culverts), New Brunswick, New Jersey.
- Union Oil Company of California, Wm. L. Soleau, comptroller; Alexander Sclater, manager, sales department, Union Oil Building, Los Angeles, California.
- United Gas Improvement Company, The, Samuel T. Bodine, president; Paul Thompson, vice-president; Walter H. Fulweiler, manager, road department, Philadelphia, Pennsylvania.
- U. S. Asphalt Refining Company, O. E. Thurber, vice-president; Geo. L. Whitney, secretary; Jos. R. Draney, sales manager, 90 West Street, New York City.
- U. S. Cast Iron Pipe and Foundry Company, L. R. Lemoine, president; Geo. J. Long, vice-president; B. F. Haughton, secretary and treasurer, Morris Building, Philadelphia, Pennsylvania.
- U. S. Wood Preserving Company, 165 Broadway, New York City.
- Wadsworth Stone and Paving Company, The, W. C. Thoma, president and general manager; J. A. Siedle, secretary and treasurer, Lambert Street and Pennsylvania Railroad, Pittsburgh, Pennsylvania.
- Waring-Underwood Company (Ideal expansion joint), Commercial Trust Building, Philadelphia, Pennsylvania.
- Warner-Quinlan Asphalt Company, W. W. McFarland, sales manager, 7 Wall Street, New York.
- Warren Brothers Company, George C. Warren, president and general manager; Chas. W. Young, vice-president; Ralph H. Warren, treasurer; Albert C. Warren, secretary, 59 Temple Place, Boston, Massachusetts.
- Washington Block and Asphalt Tile Company, R. H. Johnson, president, Washington, D. C.
- Wern Stone Paving Company (granite blocks), 55 Liberty Street, New York City.
- Western Bridge and Construction Company, Bee Building, Omaha, Nebraska.

Westrumite Company, The, J. A. Gill, president; G. S. van Westrum, vice-president; J. H. Fowler, secretary; F. J. Smith, treasurer, all at Whiting, Indiana.

Whalen Form (culvert forms), Edward J. Whalen, Syracuse, New York.
Wood and Company, R. D. (cast iron culvert pipe), Philadelphia, Pennsylvania.

Wycoff Pipe and Creosoting Company, The, 48 Church Street, New York City.

Wyoming Shovel Works, Wyoming, Pennsylvania.

York Bridge Company, York, Pennsylvania.

Young and Sons (engineering instruments), Philadelphia, Pennsylvania.

Dealers in or Agents for Road Making Machinery and Material

Austin Machinery Company, W. E. (contractors equipment), W. E. Austin, president, 2 Spring Street, Atlanta, Georgia.

Bacon, Edward R. (contractors equipment), 38-40 Natoma Street, San Francisco, California.

Baker Jr., John (oils), 17 Battery Place, New York City.

James S. Barron, 127 Franklin Street, New York City.

Bond Company, Harold L., of New York, Harold L. Bond, president; Howard C. Weaver, secretary-treasurer; Geo. S. Hedge, vice-president; 78-80 Bridge Street, New York City.

Carpenter Supply Company, C. N. (grader, scraper, spreader and leveler), Canton, Ohio.

Lima Contractors Supply Company, Delphos, Ohio.

McCoy Company, Henry J., Henry J. McCoy, president; Jas. W. McCoy, vice-president; John G. Wentink, treasurer; Frank E. Hall, secretary, 65 Dey Street, New York City.

Good Roads Supply Company, Horatio S. Earle, president; Earl I. Heenan, vice-president; L. J. Brown, secretary and treasurer; Ford Building, Detroit Michigan.

Good Roads Machinery Company, The, Kennett Square, Pennsylvania.

Ritchey Supply Company, Geo. E., Columbus, Ohio.

Road Supply and Metal Company, F. L. Carswell, secretary, Topeka, Kansas.

Shannon and Company, J. Jacob (contractors equipment), Leon Rosenbaum, secretary, 1744 Market Street, Philadelphia, Pennsylvania.

Portland Cement Manufacturers

Acme Cement Corporation, 8 West 40th Street, New York City.

Aetna Portland Cement Company, Union Trust Building, Detroit, Michigan.

Allentown Portland Cement Company, Allentown, Pennsylvania.

Alpha Portland Cement Company, Easton, Pennsylvania.

Alsen's American Portland Cement Works, 45 Broadway, New York City.

Altoona Portland Cement Company, North Altoona, Kansas.

Ash Grove Lime and Portland Cement Company, Grand Ave. Temple, Kansas City, Missouri.

Associated Cement Company, Ltd., Victoria, British Columbia.

Atlas Portland Cement Company, 30 Broad Street, New York City, New York.

Bath Portland Cement Company, Newark, New Jersey.

Beaver Portland Cement Company, N. W. Bank Building, Portland Oregon.

Bonner Portland Cement Company, Victor Building, Kansas City, Missouri.
 British Columbia Portland Cement Company, Ltd., 615 Hastings Street West, Vancouver, British Columbia.
 Burt Portland Cement Company, Bellevue, Michigan.
 California Portland Cement Company, American Bank Building, Los Angeles, California.
 Canada Cement Company, Limited, Montreal, Canada.
 Cape Girardeau Portland Cement Company, Cape Girardeau, Missouri.
 Castalia Portland Cement Company, Publication Building, Pittsburgh, Pennsylvania.
 Cayuga Lake Cement Company, Ithaca, New York.
 Chanute Cement Company, Chanute, Kansas.
 Chicago Portland Cement Company, 30 N. LaSalle Street, Chicago, Illinois.
 Clinchfield Portland Cement Corporation, Kingsport, Tennessee.
 Colorado Portland Cement Company, Denver, Colorado.
 Continental Portland Cement Company, St. Louis, Missouri.
 Coosa Portland Cement Company, Ragland, Alabama.
 Coplay Cement Manufacturing Company, Land Title Building, Philadelphia, Pennsylvania.
 Cowell Portland Cement Company, 2 Market Street, San Francisco, California.
 Crescent Portland Cement Company, Wampum, Pennsylvania.
 Dewey Portland Cement Company, Scarritt Building, Kansas City, Missouri.
 Dexter Portland Cement Company, Nazareth, Pennsylvania.
 Diamond Portland Cement Company, Williamson Building, Cleveland, Ohio.
 Diamond Portland Cement Company, Thalheimer Building, Phoenix, Arizona.
 Dixie Portland Cement Company, Chattanooga, Tennessee.
 Edison Portland Cement Company, Stewartville, New Jersey.
 Edmonton Portland Cement Company, Edmonton, Alberta, Canada.
 Fort Dodge Portland Cement Corporation, First National Bank Building, Fort Dodge, Iowa.
 Fredonia Portland Cement Company, Fredonia, Kansas.
 German-American Portland Cement Works, La Salle, Illinois.
 Giant Portland Cement Company, 604 Pennsylvania Building, Philadelphia, Pennsylvania.
 Glens Falls Portland Cement Company, Glens Falls, New York.
 Golden State Portland Cement Company, Marsh-Strong Building, Los Angeles, California.
 Great Western Portland Cement Company, Scarritt Building, Kansas City, Missouri.
 Hanover Portland Cement Company, Ltd., Hanover, Ontario, Canada.
 Helderberg Cement Company, Albany, New York.
 Huron Portland Cement Company, Ford Building, Detroit, Michigan.
 Idaho Portland Cement Works, Peyton Building, Spokane, Washington.
 Inland Portland Cement Company, Old National Bank Building, Spokane, Washington.
 International Portland Cement Company, Ltd., Old National Bank Building, Spokane, Washington.
 Iola Portland Cement Company, Iola, Kansas.
 Iowa Portland Cement Company, Des Moines, Iowa.
 Ironton Portland Cement Company, Ironton, Ohio.
 Kirkfield Portland Cement Company, Ltd., 15 Wellington Street, Toronto, Ontario, Canada.
 Knickerbocker Portland Cement Company, 30 East 42d Street, New York City.

Kosmos Portland Cement Company, Kosmosdale, Kentucky.
Lawrence Portland Cement Company, 1 Broadway, New York City.
Lehigh Portland Cement Company, Allentown, Pennsylvania.
Louisville Cement Company, Louisville, Kentucky.
Maple Leaf Portland Cement Company, Ltd., Toronto, Ontario, Canada.
Marquette Cement Manufacturing Company, Marquette Building, Chicago, Illinois.
Michigan Portland Cement Company, Chelsea, Michigan.
Millen Company, Thomas, Jamesville, New York.
Monarch Cement Company, Humboldt, Kansas.
National Portland Cement Company, Durham, Ontario, Canada.
Nazareth Cement Company, Nazareth, Pennsylvania.
Nebraska Portland Cement Company, City National Bank Building, Omaha, Nebraska.
Newaygo Portland Cement Company, Grand Rapids, Michigan.
New Egyptian Portland Cement Company, Dime Bank Building, Detroit, Michigan.
Northwestern States Portland Cement Company, Mason City, Iowa.
Ogden Portland Cement Company, Ogden, Utah.
Oklahoma Portland Cement Company, Ada, Oklahoma.
Old Mission Portland Cement Company, Crocker Building, San Francisco, California.
Olympic Portland Cement Company, Ltd., Seattle, Washington.
Ontario Portland Cement Company, Ltd., Brantford, Ontario, Canada.
Oregon Portland Cement Company, Oswego, Oregon.
Pacific Portland Cement Company, Pacific Building, San Francisco, California.
Peerless Portland Cement Company, Union City, Michigan.
Peninsular Portland Cement Company, Jackson, Michigan.
Penn-Allen Cement Company, Allentown, Pennsylvania.
Pennsylvania Cement Company, 29 Broadway, New York City, New York.
Phoenix Portland Cement Company, Nazareth, Pennsylvania.
Portland Cement Company of Utah, Salt Lake City, Utah.
Riverside Portland Cement Company, Los Angeles, California.
Rocky Mountain Cement Company, Ltd., P. Burns Building, Calgary, Alberta, Canada.
San Antonio Portland Cement Company, San Antonio, Texas.
Sandusky Portland Cement Company, Sandusky, Ohio.
Santa Cruz Portland Cement Company, Crocker Building, San Francisco, California.
Security Cement and Lime Company, Baltimore, Maryland.
Southern States Portland Cement Company, Rockmart, Georgia.
Southwestern Portland Cement Company, El Paso, Texas.
Standard Portland Cement Company, Charleston, South Carolina.
Standard Portland Cement Corporation, San Francisco, California.
St. Mary's Cement, Ltd., Montreal, Canada.
Superior Portland Cement Company, Cincinnati, Ohio.
Superior Portland Cement Company, Hoge Building, Seattle, Washington.
Texas Portland Cement Company, Cement, Texas.
Three Forks Portland Cement Company, Butte, Montana.
Tidewater Portland Cement Company, Baltimore, Maryland.
Trinity Portland Cement Company, Dallas, Texas.
Tulsa Portland Cement Corporation, Tulsa, Oklahoma.
Union Sand and Material Company, International Life Building, St. Louis, Missouri.
Union Cement Company, Ltd., 28 King Street West, Toronto, Ontario, Canada.

Union Portland Cement Company, Ogden, Utah.
 United States Portland Cement Company, Denver, Colorado.
 Universal Portland Cement Company, 208 South La Salle Street, Chicago, Illinois.
 Vancouver Portland Cement Company, Ltd., Victoria, British Columbia, Canada.
 Virginia Portland Cement Company, 26 Beaver Street, New York City, New York.
 Vulcanite Portland Cement Company, Land Title Building, Philadelphia, Pennsylvania.
 Wabash Portland Cement Company, Ford Building, Detroit, Michigan.
 Washington Portland Cement Company, White Building, Seattle, Washington.
 Western States Portland Cement Company, Independence, Kansas.
 Whitehall Cement Manufacturing Company, Land Title Building, Philadelphia, Pennsylvania.
 Wolverine Portland Cement Company, Coldwater, Michigan.
 Wyandotte Portland Cement Company, Wyandotte, Michigan.

Paving Brick Manufacturers

Adamantine Clay Products Company, North Mountain, West Virginia.
 Albion Vitriified Brick Company, Albion, Illinois.
 Allentown Paving Brick Company, Allentown, Pennsylvania.
 Alliance Brick Company, Alliance, Ohio.
 Alliance Clay Product Company, J. B. Wilcox, Alliance, Ohio.
 Alton Brick Company, Eben Rodgers, Alton, Illinois.
 American Sewer Pipe Company, A. S. McComb, Akron, Ohio.
 Ashtabula Shale Brick Company, N. C. Ralph, Ashtabula, Ohio.
 Atchison Paving Brick Company, Atchison, Kansas.
 Athens Brick Company, W. N. Alderman, Athens, Ohio.
 Banner Clay Works, Edwardsville, Illinois.
 Barber Asphalt Paving Company, Des Moines, Iowa.
 Barr Clay Company, The, C. C. Barr, Streator, Illinois.
 Beer, Paul, Des Moines, Iowa.
 Bessemer Limestone Company, C. C. Blair, Youngstown, Ohio.
 Big Four Clay Company, G. O. French, Canton, Ohio.
 Binghamton Paving Block Company, Binghamton, New York.
 Bloomfield Brick Company, Bloomfield, Indiana.
 Boone Brick, Tile and Paving Company, W. H. Brecht, Boone, Iowa.
 Brick and Stone Company, The, A. L. Moredock, Waynesburg, Pennsylvania.
 Brick, Terra Cotta and Tile Company, Corning, N. Y.
 Buffalo Brick Company, Buffalo, Kansas.
 Burke Brothers Brick Company, Fort Smith, Arkansas.
 Burton-Townsend Company, The, R. C. Burton, Zanesville, Ohio.
 Carlyle Paving Brick Company, G. E. Carlyle, Portsmouth, Ohio.
 Clearfield Brick Manufacturing Company, Clearfield, Pennsylvania.
 Clearfield Clay Working Company, Clearfield, Pennsylvania.
 Cleveland Brick and Clay Company, F. M. Brady, Cleveland, Ohio.
 Clinton Paving Brick Company, J. W. Robb, Clinton, Indiana.
 Clymer Brick Company, Clymer, Pennsylvania.
 Coffeyville Shale Brick Company, Coffeyville, Kansas.
 Coffeyville Vitriified Brick and Tile Company, Coffeyville, Kansas.
 Copeland-Ingles Shale Brick Company, Birmingham, Alabama.
 Corry Brick and Tile Company, D. Warren De Rosay, Corry, Pennsylvania.
 Danville Brick Company, W. P. Whitney, Danville, Illinois.

Deckman-Duty Brick Company, C. J. Deckman, S. M. Duty, Cleveland, Ohio.
Denny-Renton Clay and Coal Company, Seattle, Washington.
Detroit Vitrifed Brick Company, Detroit, Michigan.
Du Bois-Butler Brick Company, Du Bois, Pennsylvania.
Flint Brick and Coal Company, Des Moines, Iowa.
Foster Sales Company, Bradford, Pennsylvania.
Freeport Clay Products Company, Freeport, Pennsylvania.
Fultonham Brick Company, East Fultonham, Ohio.
Georgia Vitrifed Brick and Clay Company, Augusta, Georgia.
Glen-Gery Brick and Cement Company, Reading, Pennsylvania.
Gloninger and Maxwell, Pittsburgh, Pennsylvania.
Graves Shale Paving Brick Company, Birmingham, Alabama.
Hammond Fire Brick Company, T. I. Brett, Fairmont, West Virginia.
Hankinson and Hagler, Augusta, Georgia.
Harris Brick Company, Cincinnati, Ohio.
Hocking Valley Brick Company, L. J. Murphy, Nelsonville, Ohio.
Hydraulic Pressed Brick Company, St. Louis, Missouri.
Independence Brick Company, Independence, Kansas.
Indiana Paving Brick and Block Company, Indianapolis, Indiana.
Jamestown Paving Brick Company, Jamestown, New York.
Kelly Brick Company, Wm. P. Winder, Pennsylvania.
Kline Brick Company, John, Wickliffe, Ohio.
Kushequa Brick Company, E. K. Kane, Kushequa, Pennsylvania.
Layton Fire Clay Company, McKeesport, Pennsylvania.
Lincoln Paving Block Company, G. O. French, Canton, Ohio.
Los Angeles Pressed Brick Company, Los Angeles, California.
Mack Manufacturing Company, Philadelphia, Pennsylvania.
Marion Brick Works, Montezuma, Indiana.
Martinsville Brick Company, Martinsville, Indiana.
Massillon Brick Company, Massillon, Ohio.
Mayer Brick Company, C. P., Bridgeville, Pennsylvania.
McAvoy Vitrifed Brick Company, 1345 Arch Street, Philadelphia, Pennsylvania.
Medora Shale Brick Company, C. C. McMillan, Medora, Indiana.
Metropolitan Paving Brick Company, J. G. Barbour, Canton, Ohio.
Michigan Vitrifed Brick Company, Bay City, Michigan.
Murphysboro Paving Brick Company, E. St. Louis, Illinois.
Nelsonville Brick Company, C. H. Doan, Nelsonville, Ohio.
Newburgh Brick and Clay Company, J. R. Zmunt, Cleveland, Ohio.
New Hope Vitrifed Brick Company, New Hope, Pennsylvania.
Noble Brick Company, Glenwood, Ohio.
Novelty Brick and Coal Company, Newcomerstown, Ohio.
Oakland Paving Brick Company, Decota, California.
Patten Clay Company, Patten, Pennsylvania.
Patterson Clay Products Company, Clearfield, Pennsylvania.
Pennsylvania Clay Company, Pittsburgh, Pennsylvania.
Peebles Paving Brick Company, F. L. Manning, Portsmouth, Ohio.
Pittsburgh Vitrifed Paving and Building Brick Company, Kansas City, Missouri.
Poston, C. E., Attica, Indiana.
Poston Paving Brick Company, J. M. Waugh, Crawfordsville, Indiana.
Portsmouth Granite Brick Company, Firebrick, Kentucky.
Puritan Brick Company, Hamden, Ohio.
Purinton Paving Brick Company, Galesburg, Illinois.
Reynoldsville Brick and Tile Company, Reynoldsville, Pennsylvania.
Saginaw Paving Brick Company, Saginaw, Michigan.

Scioto Fire Brick Company, C. W. Turner, Sciotoville, Ohio.
 Sharon Clay Products Company, W. C. Taylor, Sharon, Pennsylvania.
 Shawmut Paving Brick Company, Alfred Yates, Shawmut, Pennsylvania.
 Smith, Company, A. F., P. A. Smith, New Brighton, Pennsylvania.
 Soisson, Fire Brick Company, Jos., Bolivar, Pennsylvania.
 South Zanesville Sewer Pipe and Brick Company, J. C. Bolen, Jr., Zanesville, Ohio.
 Southern Clay Manufacturing Company, Chattanooga, Tennessee.
 Southern Fire Brick and Clay Company, Montezuma, Indiana.
 South Webster Brick and Tile Company, South Webster, Ohio.
 Springfield Paving Brick Company, Springfield, Illinois.
 Standard Brick Company, Crawfordsville, Indiana.
 Standard Clay Company, Tacoma, Washington.
 Standard Shale Company, Youngsville, Pennsylvania.
 Standard Vitrified Brick Company, Coffeyville, Kansas.
 Sterling Brick Company, Olean, New York.
 Stipp, Peter, successor to Scranton Vitrified Brick Company, Scranton, Pennsylvania.
 Streator Paving Brick Company, E. F. Plumb, Streator, Illinois.
 Suburban Brick Company, Moundsville, West Virginia.
 Terre Haute Vitrified Brick Company, J. M. Hoskins, Terre Haute, Indiana.
 Thorton Fire Brick Company, D. R. Potter, Clarksburg, West Virginia.
 Thurber Brick Company, Thurber, Texas.
 Tidewater Paving Brick Company, Catskill, New York.
 Toronto Fire Clay Company, Toronto, Ohio.
 Trimble Brick Manufacturing Company, J. H. Simpson, Dayton, Ohio.
 Tulsa Brick Company, Tulsa, Oklahoma.
 Tuna Valley Pressed Brick Company, Bradford, Pennsylvania.
 United Brick Company, G. H. Francis, Greensburg, Pennsylvania.
 United Fire Brick Company, Uniontown, Pennsylvania.
 Vinton Brick Company, Dayton, Ohio.
 Vulcan Brick Company, Wellsville, Ohio.
 Wabash Clay Company, Veedersburg, Indiana.
 Watsontown Brick and Clay Products Company, Watsontown, Pennsylvania.
 Western Clay Manufacturing Company, C. H. Bray, Helena, Montana.
 Westport Paving Brick Company, John W. Hall, Baltimore, Maryland.
 Windsor Brick Company, J. T. Windsor, Akron, Ohio.
 Windsor Brick and Tile Company, Sedalia, Missouri.
 Wooster Shale Brick Company, W. R. Barnhardt, Jr., Wooster, Ohio.
 Youngsville Brick and Tile Company, Bradford, Pennsylvania.

Wood Paving Block Manufacturers

American Creosoting Company, Marion, Illinois.
 American Creosoting Company, Louisville, Kentucky.
 American Creosoting Company, Newark, New Jersey.
 American Creosoting Company, 17 Battery Place, New York City.
 American Creosote Works, New Orleans, Louisiana.
 Ayer and Lord Tie Company, Argenta, Arkansas.
 Ayer and Lord Tie Company, Carbondale, Illinois.
 Ayer and Lord Tie Company, Grenada, Mississippi.
 Barber Asphalt Paving Company, Maurer, New Jersey.
 Canada Creosoting Company, Louisville, Kentucky.
 Chicago, Burlington and Quincy Railroad, Galesburg, Illinois.
 Chicago Creosoting Company, Chicago, Illinois.
 Colman Creosoting Company, Seattle, Washington.

Columbia Creosoting Company, Portland, Oregon.
Compressed Wood Preserving Company, The, Cincinnati, Ohio.
Creosoted Wood Block Paving Company, New Orleans, Louisiana.
Eppinger and Russell Company, Long Island City, New York.
Great Northern Railway Company, St. Paul, Minnesota.
Gulfport Creosoting Company, Gulfport, Mississippi.
Indiana Creosoting Company, Louisville, Kentucky.
International Creosote and Construction Company, Beaumont, Texas.
International Creosote and Construction Company, Texarkana, Texas.
Jennison Wright Company, Toledo, Ohio.
Kettle River Company, The, Madison, Illinois.
Kettle River Company, The, Sandstone, Minn.
Louisville and Nashville Railroad Company, Louisville, Kentucky.
Michigan Wood Preserving Company, Pittsburgh, Pennsylvania.
National Lumber and Creosoting Company, Texarkana, Arkansas.
New Orleans Wood Preserving Company, New Orleans, Louisiana.
Northern Pacific Railway, St. Paul, Minnesota.
Oregon-Washington Railroad and Navigation Company, Portland, Oregon.
Pennsylvania Railroad, Philadelphia, Pennsylvania.
Pioneer Lumber and Creosoting Company, Ensley, Alabama.
Pittsburgh Wood Preserving Company, Pittsburgh, Pennsylvania.
Puget Sound Wood Preserving Company, Lowell, Washington.
Republic Creosoting Company, Mobile, Alabama.
Republic Creosoting Company, Indianapolis, Indiana.
Republic Creosoting Company, Minneapolis, Minnesota.
St. Paul and Tacoma Lumber Company, Tacoma, Washington.
Shreveport Creosoting Company, Shreveport, Louisiana.
Southern Creosote Company, Ltd., Slidell, Louisiana.
Southern Pacific Railway, San Francisco, California.
Southern Paving Construction Company, Chattanooga, Tennessee.
Southern Wood Preserving Company, Atlanta, Georgia.
U. S. Wood Preserving Company, Norfolk, Virginia.
Wyckoff Pipe Creosoting Company, Portsmouth, Virginia.

TRADE NAMES

Road Materials

- Acme Asphalt:** Trade name given to asphalt cement produced by Warren Brother Company, 59 Temple Place, Boston, Massachusetts.
- Agasco:** A refined road tar manufactured by the Atlanta Gas Light Company, Electric and Gas Building, Atlanta, Georgia.
- Alpha:** Brand of Alpha Portland Cement Company, Easton, Pennsylvania.
- Alsen:** Brand of Alsen's American Portland Cement Works, 45 Broadway, New York.
- American:** Tar binders made by American Tar Products Company, 208 South LaSalle Street, Chicago.
- Apollo:** Steel sheets for culverts made by American Sheet and Tin Plate Company, Frick Building, Pittsburgh, Pennsylvania.
- Armco American Ingot Iron:** Pure iron for rust resisting culverts. American Rolling Mill Company, Middletown, Ohio.
- Armco:** Armco iron culverts made by The Dixie Culvert and Metal Company, Atlanta, Georgia.
- Asfaltol:** Gulf Refining Company, 514 Battery Park, New York, New York. The trade name for several grades of fluid reduced petroleum for use in the surface treatment of roads.
- Ash Grove:** Brand of Ash Grove Lime and Portland Cement Company, Kansas City, Missouri.
- Asphaltolene:** Alden Spears's Sons Company, Boston, Massachusetts. The trade name of several grades of reduced and residual petroleum and oil asphalt manufactured by this company for use in hot and cold surface treatment and in the construction of roads.
- Asphalt Block:** For pavements. The Hastings Pavement Company, New York City.
- Atlantic:** Asphalts and oils produced by The Atlantic Refining Company, 3144 Passyunk Avenue, Philadelphia.
- Atlas:** Brand of the Atlas Portland Cement Company, 30 Broad Street, New York.
- Astec:** United States Asphalt Refining Company, 90 West Street, New York, New York. An asphalt produced from Mexican maltha.
- Barrett:** Paving pitch, expansion joints and creosote produced by the Barrett Company, New York.
- Bath:** Brand of Bath Portland Cement Company, Essex Building, Newark, New Jersey.
- Bear:** Brand of Golden State Portland Cement Company, Los Angeles, California.
- Bermudez Road Asphalt:** Barber Asphalt Paving Company, Philadelphia, Pennsylvania. Fluxed Bermudez Lake asphalt for use in road construction.
- Bessemer:** Paving blocks produced by Bessemer Limestone Company, Youngstown, Ohio.
- Bicomac:** Headley Good Roads Company, 30th and Spruce Streets, Philadelphia, Pennsylvania. An emulsified bitumen which is diluted with water and mixed with Portland cement concrete in the surfacing of roads.

- Bitulithic:** Warren Brothers Company, 59 Temple Place, Boston, Massachusetts. Trade name of a patented pavement construction consisting of varying sizes of crushed stone or gravel mixed with bituminous cement, the sizes of crushed stone varying from a maximum which is about one-half the depth of the pavement surface (which surface is generally 2 inches deep) to impalpable powder, being so prepared as to give a high degree of density and low percentage of voids.
- Bitustone Double Bond:** A pavement construction patented by August E. Schutte of Northboro, Massachusetts, consisting of a concrete foundation of a depth of about 3½ inches, and bonding course about 1½ inches and the spaces in the bonding course filled and the surface coated with asphaltic cement, prepared for the purpose, the surface finally finished with crusher screenings or coarse sand spread into the hot bitumen. The bonding course is made of neat cement and nearly uniform size stone or gravel (preferably 1 inch to 1½ inches in size), in proportion of one part cement to six parts stone or gravel.
- Byerlyle:** Byerly & Sons, 2484 West Fourth Street, Cleveland, Ohio. Several grades of oil asphalt for use in road construction.
- Carbo-Via:** Continental Bitumen Company, Toledo, Ohio. A refined coal tar product for use on tar bound macadam.
- Chelreco:** Chelsea Refining Company, Tulsa, Oklahoma. Several grades of fluid petroleum products for use as road oils.
- Chicago AA:** A brand of Portland cement manufactured by the Chicago Portland Cement Company, Chicago and Oglesby, Illinois.
- Clinton:** Paving brick produced by Clinton Paving Brick Company, Clinton, Indiana.
- Columbian:** Culverts, culvert forms and metal arches made by Columbian Steel Tank Company, Kansas City, Missouri.
- Concrete:** Brand of The United States Portland Cement Company, Denver, Colorado.
- Crescent:** Brand of Crescent Portland Cement Company, Wampum, Pennsylvania.
- Cubanel:** International Asphalt Company, Chamber of Commerce Building, Chicago, Illinois. A fluxed Cuban asphalt for use in paving and road construction.
- Double Bond Cement:** Warren Brothers Company, 59 Temple Place, Boston, Massachusetts. Trade name given to the asphalt cement used for the bonding course of the Bitustone Double Bond Pavement.
- Du Pont:** Explosives for quarrying. E. I. du Pont de Nemours Powder Company, Wilmington, Delaware.
- Duraz:** Wern Machinery and Engineering Company, 30 Church Street, New York, N. Y. The trade name for a type of pavement or road surface composed of small cubical granite blocks.
- Dustoline:** The Dustoline for Roads Company, Summit, New Jersey. The copyrighted trademark name of a transparent, reddish colored compound, of refined, nonasphaltic petroleum products, used as a dust preventive and road preserver.
- Econo:** Steel reinforcement made by North Western Expanded Metal Company, 407 South Dearborn Street, Chicago, Illinois.
- Fairfield:** The Impervious Product Company, 400 E. Fayette Street, Baltimore, Maryland. The trade name for the products of this company, such as "Anti-Dust," "Road Binders," and "Fairfield Asphalt." The latter, which forms the basis of their other products, is said to come from a neutralized and weathered sludge acid deposit.
- Giant:** Brand of Giant Portland Cement Company, Pennsylvania Building, Philadelphia, Pennsylvania.

- Glutrin:** Robeson Process Company, 18 East 41st Street, New York City. An adhesive liquor containing organic acids manufactured from the lignone compounds produced in the making of wood pulp by the sulfite process.
- Golden Gate:** Brand of Pacific Portland Cement Company, Consolidated, San Francisco, California.
- Hassam Pavement:** Hassam Paving Company, Worcester, Massachusetts. A patented form of concrete pavement constructed by grouting the rolled stone with a fluid grout of sand and Portland cement.
- Hastings:** Asphalt blocks produced by the Hastings Pavement Company, New York, New York.
- Hydrolene:** The Sun Company, 1421 Chestnut Street, Philadelphia, Pennsylvania. Oil asphalt for use in road construction.
- Hy-Tex:** Paving brick made by Hydraulic-Press Brick Company, St. Louis, Missouri.
- Indian:** Indian Refining Company, 17 Battery Place, New York. The trade name for several grades of reduced and residual petroleum and oil asphalt for use in hot and cold surface treatment and in the construction of roads.
- Iola:** Brand of The Iola Portland Cement Company, Kansas City, Missouri.
- Iron-ton:** Brand of The Iron-ton Portland Cement Company, Iron-ton, Ohio.
- K. C.:** Brand of Portland Cement made by Union Sand and Material Company, St. Louis, Missouri.
- Knickerbocker:** Brand of Knickerbocker Portland Cement Company, 30 East 42d Street, New York, New York.
- Kreolite:** Wood paving blocks and paving cement produced by The Jennison-Wright Company, 313 Huron Street, Toledo, Ohio.
- Kyrook:** Wadsworth Stone and Paving Company, Lambert Street, and Penna. R. R., Pittsburgh, Pennsylvania. A natural rock asphalt found in Kentucky.
- Lewis Road Tar:** The F. J. Lewis Manufacturing Company, 2505 South Robey Street, Chicago, Illinois. A scientifically prepared coal tar product.
- Medusa:** Brand of Sandusky Portland Cement Company, Cleveland, Ohio.
- Metropolitan:** Paving blocks made by The Metropolitan Paving Brick Company, Canton, Ohio.
- Meyer:** Paving block made by C. P. Meyer Brick Company, Bridgeville, Pennsylvania.
- Michigan:** Brand of the Michigan Portland Cement Company, Chelsea, Michigan.
- Monarch:** Sunset Monarch Oil Company of California, 60 California Street, San Francisco, Calif. The trade name for a heavy oil.
- Montezuma:** Warner-Quinlan Asphalt Company, 79 Wall Street, New York, N. Y. Several grades of Mexican oil-asphalt for use in street and road construction.
- Mount Diablo:** Brand of the Cowell Portland Cement Company, San Francisco, California.
- Munnsville Sperry:** Sectional culverts made by Munnsville Plow and Culvert Company, Munnsville, New York.
- National:** Bituminized Road Company, Kansas City, Missouri. Trade name of a patented product which consists of earthy material of any kind and a bituminous binder. The earthy material is subjected to a disintegrating treatment, which reduces it to a fine, dry dust that renders it capable of absorbing and combining with the bituminous binder.
- Neuchatel:** The Neuchatel Asphalte Company, Ltd., 79 Tompkins Street, New York. A rock asphalt mined at the Val de Travers mines located at Canton of Neuchatel, Switzerland.

- Northwestern:** Brand of Northwestern States Portland Cement Company, Mason City, Iowa.
- OK:** Brand of Oklahoma Portland Cement Company, Ada, Oklahoma.
- Old Style:** Pitch filler made by American Tar Products Company, 208 South La Salle Street, Chicago.
- Patton:** Paving brick made by Patton Clay Manufacturing Company, Patton, Cambria County, Pennsylvania.
- Pioneer:** Asphalts containing gilsonite, made by The Pioneer Asphalt Company, Lawrenceville, Illinois.
- Portsmouth:** Paving brick made by The Portsmouth Paving Brick Company, Portsmouth, Ohio.
- Poston:** Paving brick made by C. E. Poston, Attica, Indiana.
- Progressive Culverts:** Combination cast iron and corrugated iron, also pure iron culvert pipe. Manufactured by American Culvert Manufacturing Company, Buechel, Kentucky.
- Prudential:** Asphalt produced by Prudential Oil Company, 17 Battery Place, New York.
- Red Ring:** Brand of Portland Cement of Union Sand and Material Company, St. Louis, Missouri.
- Roadamite:** National Roadamite Paving Supply Company, 2 and 3 H. W. Hellman Building, Los Angeles, Calif. The trade name for an asphaltic cement prepared from California petroleum.
- Rocmac:** Rocmac Road Corporation of America, Cleveland, Ohio. A chemical mixture containing silicate of soda, sugar, powdered limestone, and other ingredients with which the upper course in macadam or gravel construction is puddled.
- Royal:** Brand of Dixie Portland Cement Company, Chattanooga, Tennessee.
- Sarco:** Standard Asphalt and Rubber Company, 208 South La Salle Street, Chicago, Illinois. Several grades of asphalt containing Gilsonite, for use in road construction.
- Sarcolithic:** Standard Asphalt and Rubber Company, 208 South La Salle Street, Chicago, Illinois. The trade name for a form of pavement consisting of a graded crushed stone aggregate which is mixed with Sarco Asphaltic Cement.
- Shawmut:** Brand of Shawmut Vitrified Paving Brick Works, Shawmut, Pennsylvania.
- Socony:** Brand name of asphalts, oils and fluxes of Standard Oil Company of New York, 26 Broadway, New York.
- Solvay:** Granulated calcium chloride produced by Semet-Solvay Company, Syracuse, New York.
- Standard:** Standard Oil Company of New York, and Standard Oil Company of New Jersey, 26 Broadway, New York. "Standard Refined Mexican Asphalt," "Standard Macadam Asphalt Binders," "Standard Asphalt Road Oils," prepared by these Companies for use in sheet asphalt paving, bituminous macadam construction and cold surface treatment of macadam and gravel roads.
- Sterling:** Paving brick made by Sterling Brick Company, Olean, New York.
- Tarite:** The American Tar Company, Malden, Massachusetts. A refined coal tar product for use in road construction. "Tarite Asphalt" is a refined coal tar containing a certain percentage of oil asphalt. "Tarine," a refined tar preparation for use in construction work or in surface treatments.
- Tarvia:** The Barrett Company, 17 Battery Place, New York, New York. A trade name of this Company for their tar products used for road purposes. "Tarvia A" for hot surface treatment: "Tarvia B" for cold surface treatment: "Tarvia X" for penetration or mixing method in road construction.

- Tascoal:** The Alden Speare's Sons Company, Boston, Massachusetts. A colorless oil distillate for use as a dust layer.
- Terracolio:** Headley Good Roads Company, Real Estate Trust Building, Philadelphia, Pennsylvania. An emulsified semi-asphaltic oil which may be diluted and used in the surface treatment of roads.
- Texaco:** John Baker, Jr., New York, Chicago, Boston, Philadelphia, Baltimore, Richmond, Birmingham, New Orleans, Buffalo, Albany, Minneapolis, Kansas City, Denver, Tampa and Toledo. All the Texaco road products are marketed under the registered trade name "Texaco." They are "Texaco Road Oil for Cold Application," "Texaco Road Oil for Hot Application," "Texaco Liquid Asphalt," "Texaco Macadam Binder," "Texaco Road Asphalt," "Texaco Paving Filler," "Texaco Paving Cement."
- Toronto:** Paving brick produced by The Toronto Fire Clay Company, Toronto, Ohio.
- Trinidad Liquid Asphalt:** Barber Asphalt Paving Company, Land Title Building, Philadelphia, Pennsylvania. Natural liquid asphalt for the surface treatment of roads, obtained from the Island of Trinidad; "A" to be used cold; "B" to be applied hot.
- Ugite:** The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania. The trade name for fluid and semi-solid refined water-gas tar for use in surface treatment and construction. "No. 1" is applied cold as a dust layer; "No. 2" is applied hot for surface treatment; "No. 3" is recommended for construction by the penetration method; "No. 4" is recommended for construction by the mixing method.
- Union Paving Asphalt and Maltha Brand:** Union Oil Company of California, Mills Building, San Francisco. Oil asphalt refined from heavy California crudes of between 12 and 16 gravity Beaume.
- United:** Paving brick made by The United Brick Company, Greensburg, Pennsylvania.
- Universal:** Brand of the Universal Portland Cement Company, 208 South LaSalle Street, Chicago, Illinois.
- Utah:** Brand of the Portland Cement Company of Utah, Salt Lake City, Utah.
- Vulcanite:** Brand of the Vulcanite Portland Cement Company, Land Title Building, Philadelphia, Pennsylvania.
- Warrenite:** Warren Brothers Company, 59 Temple Place, Boston, Massachusetts. A modification of the bitulithic city pavement adapted to meet the traffic conditions of country roads.
- Westrumite:** The Westrumite Company, Whiting, Indiana: The Alantie Westrumite Company, Washington, D. C. An aqueous emulsion of native bitumens used cold as a binder in road construction in the following ways: (1) By mixing method (2) By penetration method (3) By surface treatment (4) As a dust layer.

Road Machinery

- Acme:** Trade name given road machines, stone crushers, scarifiers, elevator and portable stone bins manufactured by the Acme Road Machinery Company, Frankfort, New York.
- Acme:** Trade name given to metal nestable corrugated culverts manufactured by The Canton Culvert and Silo Company, Canton, Ohio.
- Ajas:** Trade name given to portable steam engines used for operating crusher plants manufactured by the A. B. Farquhar Company, York Pennsylvania.

- Apes:** Reversible dumping and spreading car. Eagle Wagon Company, Auburn, New York.
- Atlantic:** Trade name given to steam shovels manufactured by the Bucyrus Company, South Milwaukee, Wisconsin.
- Atlapump:** Trade name given to a gasoline pumping engine manufactured by the Harold L. Bond Company, 391 Atlantic Avenue, Boston, Massachusetts.
- Aurora:** Trade name given to jaw rock crusher and dump wagon manufactured by the Atstin-Western Road Machinery Company, Karpen Building, Chicago, Illinois.
- Austin:** Trade name given to motor rollers, gyratory crusher, sprinkler and reversible grader manufactured by the Austin-Western Road Machinery Company, Karpen Building, Chicago, Illinois.
- Austin-Cube:** Trade name given to concrete mixer manufactured by the Municipal Engineering and Contracting Company, Railway Exchange Building, Chicago, Illinois.
- Austin Giant:** Trade name given to grader manufactured by the Austin-Western Road Machinery Company, Karpen Building, Chicago, Illinois.
- Automatic Concrete Mixers:** Gravity mixers, Hains-Weaver Patents. By Automatic Concrete Mixer Company, Inc., 50 Church Street, New York City.
- Berger:** Surveying instruments made by C. L. Berger and Sons, 37 Williams Street.
- Big Four Gas Tractors:** Emerson-Brantingham Implement Co., Rockford, Illinois.
- Blystone Batch Mixer:** Concrete mixer. Manufactured by Blystone Manufacturing Company, Cambridge Springs, Pennsylvania.
- Boss:** Wheelbarrows and scrapers made by The Kilbourne and Jacobs Manufacturing Company, Columbus, Ohio.
- Bucyrus:** Trade name given to a steam shovel manufactured by the Bucyrus Company, South Milwaukee, Wisconsin.
- Buffalo Pitts:** Trade name given Ddl. Cyl. Two-Speed Steel Gear Road Locomotives, Contractors Special Traction Engines, Contractors Gasoline Tractors, Reversible Stone Spreading Cars—Steel Frame, Reversible Stone Spreading Cars—Wood Frame, Buffalo Pitts Road Freight Cars, and Automobile Trailers. Buffalo Pitts Company, Buffalo, New York.
- Buffalo Pitts:** Macadam, asphalt and tandem rollers, special tractors and road scarifiers made by Buffalo Steam Roller Company, Buffalo, N. Y.
- Busy Bee:** Trade name given to hammer drills manufactured by the Kiernan-Terry Drill Company, Woolworth Building, New York, New York.
- Butterfly, Bull Moose, Electric-Air, Jackhammer, Leyner-Ingersoll, Sergeant:** Trade name given to rock drills manufactured by the Ingersoll-Rand Company, 11 Broadway, New York, New York.
- Calyz:** Trade name given core drills manufactured by the Ingersoll-Rand Company, 11 Broadway, New York, New York.
- Case:** Steam rollers, gas and steam traction engines, road graders, drags, scrapers, rock crushers, elevators, screens, bins, etc. J. I. Case Threshing Machine Company, Racine, Wisconsin.
- Caterpillar:** A traction engine with endless steel belt, replacing wheels, giving additional traction in all soils. Holt Manufacturing Company, Peoria, Illinois.
- Champion:** Road rollers, crushers and road machines built by The Good Roads Machinery Company, Inc., Kennett Square, Pennsylvania.
- Chicago:** Steel tape and leveling rods made by Chicago Steel Tape Company, 6229 Cottage Grove Avenue, Chicago.
- Cincinnati:** Concrete mixers made by Ideal Concrete Machinery Company, Cincinnati.

- Olimas:** Trade name given to a steel reversible road machine and a rock crusher sold by the Good Roads Machinery Company, Inc., Marathon, New York.
- Climax Jumbo:** Trade name given a heavy road machine sold by the Good Roads Machinery Company, Inc., Marathon, New York.
- Columbian:** Trade name given to dump wagons and carts manufactured by the Columbia Wagon Company, Columbia, Pennsylvania.
- Columbus:** Wheelbarrows and scrapers made by The Kilbourne and Jacobs Manufacturing Company, Columbus, Ohio.
- Crown:** Trade name given to sand rammers manufactured by the Ingersoll-Rand Company, 11 Broadway, New York, New York.
- Cub:** Scrapers made by The Kilbourne and Jacobs Manufacturing Company, Columbus, Ohio.
- Double Shell:** Trade name given to dryers manufactured by the Ruggles-Coles Engineering Company, 50 Church Street, New York, New York.
- Dreadnought:** Road grader made by The Baker Manufacturing Company, Springfield, Illinois.
- Eagle Dump Wagon; Eagle Two Wheel Trailers; Eagle Four Wheel Trailers:** The Eagle Wagon Works, Auburn, New York.
- Electric-Air:** Trade name given to rock drills manufactured by the Ingersoll-Rand Company, 11 Broadway, New York, New York.
- Emerson Gas Tractors:** Emerson-Brantingham Implement Co., Rockford, Illinois.
- Eolus:** Wheelbarrows made by The Kilbourne and Jacobs Manufacturing Company, Columbus, Ohio.
- Etnyre:** Road sprinklers and oilers made by E. D. Etnyre and Company, Oregon, Illinois.
- Eureka:** Continuous concrete mixer, batch concrete mixers, mortar mixers, diaphragm pumping outfits. Eureka Machine Company, Lansing, Michigan.
- Everett:** Trade name given to portable dump wagon box manufactured by the Everett Manufacturing Company, Newark, New York.
- Fairbanks:** Cement-testing apparatus and scales made by Fairbanks, Morse and Company, 900 South Wabash Avenue, Chicago.
- Fairbanks-Morse:** Air compressors, boilers, dynamos, engines, hoists, motors, pumps and traction engines made by Fairbanks, Morse and Company, 900 South Wabash Avenue, Chicago, Illinois.
- Foote:** Batch concrete mixer. Foote Manufacturing Company, Munda, New York.
- Force-Feed:** Trade name given to the rock crusher manufactured by the Universal Crusher Company, Cedar Rapids, Iowa.
- Galion:** Road machinery and culverts made by The Galion Iron Works and Manufacturing Company, Galion, Ohio.
- Garford:** Motor trucks made by The Garford Motor Truck Company, Lima, Ohio.
- Giant:** Road machines of the Stockland Road Machinery Company, Minneapolis, Minnesota.
- Glide:** Trade name given to graders manufactured by the Glide Road Machine Company, Minneapolis, Minnesota.
- Hotchkiss:** Steel forms for sidewalks, curbs, and posts made by Hotchkiss Lock Metal Form Company, Binghamton, New York.
- Huber:** Road rollers, tractors, dump wagons, scarifiers and general road equipment. Huber Manufacturing Company, Marion, Ohio.
- Hvass:** Trade name given to scarifier, push brooms, street sweepers and general equipment for handling bituminous materials manufactured by the Chas. Hvass Company, East 18th and 19th Streets, Avenues A and B, New York, New York.

- Imperial, Ingersoll-Rogler:** Trade name given to air compressors manufactured by the Ingersoll-Rand Company, 11 Broadway, New York, New York.
- Imperial:** Trade name given air hoists and motors manufactured by the Ingersoll-Rand Company, 11 Broadway, New York, New York.
- Imperial:** Trade name given to riveted corrugated metal culverts manufactured by the Canton Culvert and Silo Company, Canton, Ohio.
- Jack of All Trades:** Gasoline engines made by Fairbanks, Morse and Company, 900 South Wabash Avenue, Chicago.
- Junior:** Road machine built by Stockland Road Machinery Company, Minneapolis, Minnesota.
- Kelly:** Motor trucks built by The Kelly-Springfield Motor Truck Company, Springfield, Ohio.
- K and J.:** Wheelbarrows, scrapers and plows made by The Kilbourne and Jacobs Manufacturing Company, Columbus, Ohio.
- Kinney:** Oil distributor built by The Kinney Manufacturing Company, 3529 Washington Street, Boston, Massachusetts.
- Koppel:** Industrial and portable railway material made by Orenstein-Arthur Koppel Company, Koppel, Beaver County, Pennsylvania.
- Link:** Conveyors for loading and unloading crushed stone, sand, etc., from cars or dump into wagons. Link Belt Company, Philadelphia, Pennsylvania.
- Little David:** Trade name given riveting and chipping hammers and pneumatic drills manufactured by the Ingersoll-Rand Company, 11 Broadway, New York, New York.
- Little Western:** Trade name given to grader manufactured by the Austin-Western Road Machinery Company, Karpen Building, Chicago, Illinois.
- Little Winner:** Trade name given a two-horse road machine sold by the Good Roads Machinery Company, Inc., Marathon, New York.
- Little Yankee:** Sub-grade levelers made by The Ohio Road Machinery Company, Oberlin, Ohio.
- Luts:** Surface heater for heating asphalt pavements at time of repair. Equitable Asphalt Maintenance Company, Kansas City, Missouri.
- Maney Four Wheel Scraper:** Trade names given to grader and scraper manufactured by the Baker Manufacturing Company, Springfield, Illinois.
- Marion:** Steam shovels, dredges and ballast unloaders built by The Marion Steam Shovel Company.
- Mikkola:** Shovels made by The Conneaut Shovel Company, Conneaut, Ohio.
- Milburn-Blatt:** Trade name given to dump wagon manufactured by the Milburn Wagon Company, Toledo, Ohio.
- Mogul:** Trade name given to full line of oil burning engines and tractors sold by the International Harvester Company of America, Harvester Building, Chicago, Illinois.
- Monarch:** Trade name given a combination roller and traction hauling engine sold by the Good Roads Machinery Company, Inc., Marathon, New York.
- New Era:** Trade name given to elevating grader manufactured by the Austin-Western Road Machinery Company, Karpen Building, Chicago, Illinois.
- New York:** Road rollers built by Port Huron Engine and Thresher Company, Port Huron, Michigan.
- Northfield:** Drags, scrapers, graders, culverts and concrete mixers made by Northfield Iron Company, Northfield, Minnesota.
- Oberlin:** Road drags made by The Ohio Road Machinery Company, Oberlin, Ohio.

- Ohio:** Road machines, scarifiers, gang rooter plows, subgrade levelers, wheelers, graders, drags, dump boxes. Ohio Road Machinery Company, Oberlin, Ohio.
- Olsen:** Testing machines built by Tinus Olsen Testing Machine Company, 500 North Twelfth Street, Philadelphia, Pennsylvania.
- Otto:** Trade name given an engine manufactured by The Otto Gas Engine Works, 33rd and Walnut Streets, Philadelphia, Pennsylvania.
- Panama Line:** Trade name given to road graders, road drags and cast iron culvert pipe manufactured by the F. B. Zieg Manufacturing Company, Fredericktown, Ohio.
- Pan-American:** Wheelbarrows made by The Kilbourne and Jacobs Manufacturing Company, Columbus, Ohio.
- Peerless:** Traction engines, steam road rollers. Emerson, Brantingham-Implement Company, Rockford, Illinois.
- Peerless:** Motor trucks made by The Peerless Motor Car Company, Cleveland, Ohio.
- Pennsylvania:** Trade name given to crushers manufactured by the Pennsylvania Crusher Company, Philadelphia, Pennsylvania.
- Pioneer:** Trade name given to dump wagon manufactured by the Austin-Western Road Machinery Company, Karpen Building, Chicago, Illinois.
- Pioneer:** Gas traction engines built by Pioneer Tractor Manufacturing Company, Winona, Minneapolis.
- Planet:** Wheelbarrows made by The Kilbourne and Jacobs Manufacturing Company, Columbus, Ohio.
- Pony:** Road machine built by Stockland Road Machinery Company, Minneapolis, Minnesota.
- Porcupine:** Trade name, given a scarifier manufactured by the Universal Road Machinery Company, Kingston, New York.
- Port Huron:** Trade name given to hauling engines, spreading and dumping cars manufactured by the Port Huron Engine & Thresher Company, Port Huron, Michigan.
- Port Huron:** Trade name given a road roller manufactured by the Port Huron Engine & Thresher Company, Port Huron, Michigan.
- Reeves Gas Tractors:** Emerson-Brantingham Implement Co., Rockford, Illinois.
- Reeves Traction Engines:** Emerson-Brantingham Implement Co., Rockford, Illinois.
- Reliance:** Trade name given rock crusher elevators, screens, portable stone bins and improved street sweeper manufactured by the Universal Road Machinery Company, Kingston, New York.
- Road King:** Trade name given to a road grader and Adams Leaning Wheel Graders, manufactured by J. D. Adams & Company, Indianapolis, Indiana.
- Ronberg:** Shovel made by The Conneaut Shovel Company, Conneaut, Ohio.
- Russell:** Road machinery built by Russell Grader Manufacturing Company, Minneapolis, Minnesota.
- Scientific:** Shovel made by The Conneaut Shovel Company, Conneaut, Ohio.
- Scioto:** Wheelbarrows made by The Kilbourne and Jacobs Manufacturing Company, Columbus, Ohio.
- Service:** Motor trucks built by Service Motor Truck Company, Wabash, Indiana.
- Shuart:** Land grade made by The Ohio Road Machinery Company, Oberlin, Ohio.
- Shunk:** Plows made by Shunk Plow Company, Bucyrus, Ohio.

- Simplex:** Trade name given to batch and continuous concrete mixers manufactured by The Miles Manufacturing Company, Jackson, Michigan.
- Simplified Continuous Mixer:** Trade name given to concrete mixer manufactured by Besser Manufacturing Company, Alpena, Michigan.
- Smith:** Rotary batch concrete mixers. T. L. Smith Company, Milwaukee, Wisconsin.
- Smith Chicago:** Concrete mixer, batch type, rotary. Chicago Concrete Machinery Company, Milwaukee, Wisconsin.
- Special:** Road machine made by Stockland Road Machinery Company, Minneapolis, Minnesota.
- SSS:** Mixers and pumps built by The Standard Scale and Supply Company, 243 Water Street, Pittsburgh, Pennsylvania.
- Star:** Wheelbarrows made by The Kilbourne and Jacobs Manufacturing Company, Columbus, Ohio.
- Studebaker:** Wagons, street sprinklers, sweepers and flushers, road oilers, dump wagons, boxes, carts, tank wagons, harness, automobiles, etc. Studebaker, South Bend, Indiana, and Detroit, Michigan.
- Tarco:** Trade name given to road oiling appliances manufactured by the Tarrant Manufacturing Company, Saratoga Springs, New York.
- Telemith:** Gyratory and jaw crushers, rock, ore and gravel handling equipment. Smith Engineering Works, Milwaukee, Wisconsin.
- Titan:** Trade name given to full line of oil-burning engines and tractors sold by the International Harvester Company of America, Harvester Building, Chicago, Illinois.
- The Big-an-Little:** Trade name given to concrete mixers manufactured by the Jaeger Machine Company, Columbus, Ohio.
- The Standard:** Trade name mixers and scales manufactured by the Standard Scale and Supply Company, 243 Water Street, Pittsburgh, Pennsylvania.
- The Susquehanna:** Trade name given to a dump wagon manufactured by the Columbia Wagon Company, Columbia, Pennsylvania.
- Thew:** Steam shovels for road contractors built by The Thew Automatic Shovel Company, Lorain, Ohio.
- Troy:** Wagons and trailers built by The Troy Wagon Works Company, Troy, Ohio.
- 20th Century Grader:** Trade name given to grader and scraper manufactured by The Baker Manufacturing Company, Springfield, Illinois.
- Victor:** Wheelbarrows made by The Kilbourne and Jacobs Manufacturing Company, Columbus, Ohio.
- Vortex:** Trade name given to pump engine manufactured by the Lawrence Pump & Engine Company, Lawrence, Massachusetts.
- Vulcan:** Trade names given to steam shovels manufactured by the Bucyrus Company, South Milwaukee, Wisconsin.
- Watson:** Dump wagons, trailers, etc. Watson Wagon Company, Canastota, New York.
- Western:** Trade name given to elevating grader manufactured by the Austin-Western Road Machinery Company, Karpen Building, Chicago, Illinois.
- Western Special:** Trade name given to grader manufactured by the Austin-Western Road Machinery Company, Karpen Building, Chicago, Illinois.
- Western Standard:** Trade name given to grader manufactured by the Austin-Western Road Machinery Company, Karpen Building, Chicago, Illinois.
- Wonder:** Concrete mixers made by Waterloo Cement Machinery Corporation, 201 Vinton Street, Waterloo, Iowa.

ROAD AND ALLIED ASSOCIATIONS

Permanent International Association of Road Congresses

Officer.—M. Mahieu, secretary-general, 1 Avenue d'Iena, Paris, France.

1. OBJECT AND ORGANIZATION OF THE ASSOCIATION

ARTICLE I

The object of the Permanent International Association of Road Congresses is to promote progress in the construction, traffic and exploitation of roads.

It continues the work of the first International Road Congress held in Paris in October, 1908.

It accomplishes its object: 1, By organising Road Congresses; 2, by publishing papers, proceedings, and other documents; 3, by collecting the results of (a) tests carried out on roads; (b) laboratory tests throughout the world on materials which are used or are suitable for road construction and maintenance; these tests may be either in the form of mere records collected by the Association or they may have been carried out by the Association itself or through its instrumentality.

Its affairs are managed by a Permanent International Commission.

ARTICLE II

The Association consists of:

1. Delegates of Governments and Corporations of all the countries which subscribe annually to the Association.

2. Private Members.

Membership may be either permanent or temporary.

Governments may appoint one official delegate, with a right to vote at every Congress, for each 250 francs of their annual subsidy.

This amount is reduced to 100 francs for Corporations.

Permanent Members are entitled to attend and vote at every Congress.

Temporary members are entitled to attend the particular Congress they have joined, and they may vote on all questions which do not affect the Permanent Association itself.

3. Honorary Members, nominated by the Permanent International Commission.

ARTICLE III

1. A Permanent International Commission, with headquarters at Paris, is at the head of the Association.

2. A Permanent Council and an Executive Committee are appointed from amongst the Members of this Commission.

ARTICLE IV

The Permanent International Commission is composed of members belonging to the various countries represented in the Association. Each country has the right to one representative for each 1000 francs of its total annual subsidy.

Provided, however, that the number of representatives from any one country shall not exceed 15 (fifteen), and that any country which pays not less than 250 francs shall have the right to appoint one delegate.¹

American Highway Association

The American Highway Association was organized at Washington, D. C., November 22, 1910.

Its purposes are:

To correlate and harmonize the efforts of all existing organizations working for road improvement.

To arouse and stimulate sentiment for road improvement.

To strive for wise, equitable and uniform road legislation in every State.

To aid in bringing about efficient road administration in the States and their subdivisions, involving the introduction of skilled supervision and the elimination of politics from the management of the public roads.

To seek continuous and systematic maintenance of all roads, the classification of all roads according to traffic requirements, payment of road taxes in cash, and adoption of the principle of State aid and State supervision.

To advocate the correlation of all road construction so that the important roads of each county shall connect with those of the adjoining counties and the important roads of each State shall connect with those of adjoining States.

To strive for the utilization of convict labor on works of public improvement, where that course is consistent with the local policy, so as to involve the least possible competition with free labor, the utmost public benefit, and a healthy moral and physical development of the convict. In many States these results can be attained by using the convicts on road work or the preparation of road materials.

¹ For further information address either the secretary general or the American Highway Association.

CONSTITUTION**ARTICLE I***Name*

SECTION 1. The name of this organization shall be THE AMERICAN HIGHWAY ASSOCIATION.

ARTICLE II*Object*

SECTION 1. The object of this Association is to harmonize and correlate all efforts for the improvement of the public roads, to the end that adequate and efficient systems of road construction, administration, and maintenance may be adopted in all of the States.

ARTICLE III*Location*

SECTION 1. The official headquarters of this Association shall be located and maintained in the city of Washington, D. C.

ARTICLE IV*Membership*

SECTION 1. The regular membership of this Association shall be composed of all persons who shall sign the roll of membership at the time of organization, or make written application to the Secretary and pay annual dues for one year in advance, membership to begin with written acceptance by the Secretary.

SEC. 2. The associate membership shall consist of all members of State and other organizations for road improvement, cooperating with this Association, *provided*, that a roster of such membership shall be filed with the Secretary by said organization.

SEC. 3. The sustaining membership shall consist of all persons or organizations who shall sign the roll of sustaining membership at the organization of this Association, or make written application to the Secretary and pay annual dues for sustaining membership one year in advance, membership to begin as soon as written acceptance shall have been received from the Secretary.

ARTICLE V*Officers*

SECTION 1. The officers of this Association shall consist of a President, a Vice-President, a Treasurer, and a Board of Directors, consisting of the President and Vice-President of the Association and twenty-three additional members, to be elected at the annual meeting of the Association as hereinafter provided, and such other executive officers as may be appointed by the Executive Committee.

SEC. 2. The President, Vice-President, Treasurer, and members of the Board of Directors shall be regular or sustaining members of the Association, and shall be elected at the first regular meeting and annually thereafter, except that the members of the Board, exclusive of the officers, shall be elected in three groups, the first to hold office for a period of three years, the second to hold office for a period of two years, and the third to hold office for a period of one year, vacancies on the Board to be filled annually thereafter.

ARTICLE VI*Committees*

SECTION 1. There shall be four standing committees of this Association: An Executive Committee, consisting of five members; a Finance Committee; a Committee on Membership, and an Auditing Committee, consisting of three members. The members of the Auditing Committee shall be selected by the President at the first annual meeting, and shall hold office until the next regular meeting of the Association. The members of the other three committees shall be selected by the Board of Directors, and shall hold office until the next regular meeting of the Association.

ARTICLE VII*Amendments*

SECTION 1. This Constitution may be amended at any regular meeting of the Association by three-fourths of the qualified voters present, *provided*, that the Secretary shall notify members of the Association of said regular meeting.

ARTICLE VIII*By-Laws*

SECTION 1. The Board of Directors shall make such By-Laws for the government of the Association as it may deem necessary, and which shall not conflict with the provisions of the Constitution, and may amend or alter the same.

By-Laws**ARTICLE I***Annual Dues*

SECTION 1. The annual dues for regular members of the Association shall be \$5, payable in advance. Annual dues for sustaining members shall be \$100, payable in advance. Associate members shall not be required to pay annual dues to this Association.

ARTICLE II*Voting Privileges*

SECTION 1. Regular members of the Association shall be entitled to participate in its proceedings, and vote upon all questions that may come before the Association. Associate members shall be entitled to participate in discussions of questions before the Association. Sustaining members shall be entitled to participate in discussions, and to vote upon questions before the Association.

ARTICLE III*Duties of Officers*

SECTION 1. The President shall be the executive head of the Association. He shall preside at all meetings of the Association, and shall appoint an Auditing Committee and all temporary committees.

SEC. 2. In the absence of the President the Vice-President shall act in his place and stead, *provided*, that in the absence of both the President and Vice-President the Executive Committee shall immediately elect one of its members to perform the duties of the President.

SEC. 3. The Secretary shall keep the records and minutes of the Association. He shall draw all orders upon the Treasurer for the payment of money. He shall serve all notices and perform all duties necessary to the proper conduct of the business affairs of the Association, and shall perform such additional duties as may be assigned to him by the Board of Directors. He shall make written report annually of the work of the Association, and shall make such special written reports to the Board of Directors as they may require from time to time.

SEC. 4. The Treasurer shall be the custodian of the funds of the Association. He shall pay all orders for money duly signed by the Secretary. He shall make a written report annually to the Association, accounting for all funds received and disbursed. If the Treasurer shall for good and sufficient reason be temporarily unable at any time to perform the duties of his office, he shall so inform the chairman of the Executive Committee, who shall, with the concurrence of two other members of said committee, designate one of their members to perform the duties of Treasurer, until such time as the Treasurer shall resume his duties and so inform the chairman of the Executive Committee.

SEC. 5. The Organizer shall perform such duties as are assigned to him by the Board of Directors.

SEC. 6. The Board of Directors shall at its first meeting and annually thereafter elect a chairman. The Board shall have custody of all property of the Association; shall have charge of the financial affairs of the Association; shall provide ways and means for its expenses, shall appoint all regular committees and all officers not otherwise provided for, shall have supervision and control over all work carried on by the Association and its officers, and shall fill all vacancies in its own membership and among the officers of the Association between the meetings of the Association.

ARTICLE IV

Duties of Committees

SECTION 1. The Executive Committee shall act for the Board of Directors and exercise all the powers of said Board in the interim between the meetings of said Board, and shall report quarterly to the Board the condition of the Association and its work.

SEC. 2. The Committee on Finance shall provide for the raising of funds to carry on the work of the Association and shall have supervision over the financial affairs of the Association.

SEC. 3. The Committee on Membership shall deal with all questions relating to membership in the Association, and shall take such steps as it may deem advisable for increasing the membership of the Association.

SEC. 4. The Auditing Committee shall audit and review the reports of the Secretary and the Treasurer.

ARTICLE V

Meetings

SECTION 1. Regular meetings of the Association shall be held annually at such time and place as the Board of Directors may determine. Special meetings may be called by the Board of Directors, or by two-thirds of the regular members of the Association.

SEC. 2. The Board of Directors may fix the time and place of its meetings, provided that it shall meet at least once in each year.

SEC. 3. The Executive Committee shall fix the time and place of its meeting, provided that it shall meet at least once in each three months.

ARTICLE VI

Quorums

SECTION 1. A quorum of the Association shall consist of fifty members who shall be present in person.

SEC. 2. A quorum of the Board of Directors shall consist of five members who shall be present in person.

SEC. 3. A quorum of the Executive Committee shall consist of a majority of its members.

ARTICLE VII

Amendments

SECTION. 1. The By-Laws of this Association may be altered or amended by the Board of Directors, at their discretion, *provided*, that such By-Laws shall not conflict with the provisions of the Constitution.

Fairfax Harrison, president; Logan Waller Page, vice-president; John Burke, treasurer; Leonard Tufts, chairman executive committee; Frank A. Vanderlip, chairman committee on membership; J. C. Hemphill, chairman committee on publicity; directors, James S. Harlan, chairman; Charles Whiting Baker, A. G. Batchelder, W. T. Beatty, Charles D. Blaney, S. E. Bradt, R. D. Chapin, George W. Cooley, Richard H. Edmunds, Austin B. Fletcher, Fairfax Harrison, A. R. Johnson, L. E. Johnson, Joseph W. Jones, Clarence A. Kenyon, Bryan Lathrop, E. J. Mehren, James H. Macdonald, Thomas G. Norris, Logan Waller Page, Joseph Hyde Pratt, Henry G. Shirley, Wm. D. Sohler, Leonard Tufts, W. Tom Winn; Charles P. Light, field secretary. Offices, Colorado Building, 1341 G Street N. W., Washington, D. C.

PUBLICATIONS

Good Roads Year Book of the United States, 1912, 1913, 1914 and 1915.
Addresses, Papers and Resolutions, American Road Congress, 1911, 1912, 1913 and 1914.

Good Roads Year Book, 1912, \$1.00.

Good Roads Year Book, 1913, \$1.00.

Good Roads Year Book, 1914, \$1.00.

Good Roads Year Book, 1915, \$1.00.

Proceedings of First American Road Congress, \$1.00. (Held in Richmond, Virginia, November 20-23, 1911.)

Proceedings of Second American Road Congress, \$1.00. (Held in Atlantic City, N. J., September 30-October 5, 1912.)

Proceedings of the Third American Road Congress, \$1.00. (Held in Detroit, Michigan, September 29-October 4, 1913.)

Proceedings of the Fourth American Road Congress, \$1.00. (Held in Atlanta, Georgia, November 9-14, 1914.)

Proceedings of the Pan-American Road Congress, \$1.00. (Held in Oakland, California, September 13-17, 1915.)

Bulletin 1. The relation of the contractor to the public official. C. A. Crane, secretary, The General Contractors' Association.

- Bulletin 2. Modern methods of road surface preservation by bituminous preparations. Chas. W. Ross, superintendent of streets, Newton, Mass.
- Bulletin 3. Bond issues for road improvement. Hon. Lee McClung, treasurer of the United States.
- Bulletin 4. Good roads and the cost of living. W. W. Finley, president, Southern Railway Company.
- Bulletin 5. Earth, sand-clay and similar materials, qualities and methods of application. W. S. Keller, State highway engineer of Alabama.
- Bulletin 6. Street pavements: their selection, care and maintenance. By Geo. W. Tillson, consulting engineer to the borough president, Borough of Brooklyn, New York City.
- Bulletin 7. Road administration. By Col. W. D. Sohler, chairman of the Massachusetts State Highway Commission.
- Bulletin 8. The labor problem in road construction. By P. St. J. Wilson, State highway commissioner of Virginia.
- Bulletin 9. Bond issues for road improvement. By S. E. Bradt, member Illinois State highway department.
- Bulletin 10. Systematizing the purchase of road materials and equipment. By Henry G. Shirley, chief engineer, State roads commission of Maryland.
- Bulletin 11. Highway accounting, with special reference to maintenance. By Halbert P. Gillette, M. Am. Soc. C. E., chief editor of "Engineering and Contracting."
- Bulletin 12. Unsurfaced roads. By W. S. Keller, State highway engineer of Alabama.
- Bulletin 13. The protection and upkeep of road equipment. By Daniel J. Hauer, construction economist and consulting engineer.
- Bulletin 14. Waterway structures. By A. R. Hirst, State highway engineer of Wisconsin.
- Bulletin 15. Legal suggestions respecting road contracts. By William Law Bowman, C. E., LL. B., New York Bar.
- Bulletin 16. Treatment of worn out and ravelled macadam surfaces. Address of Col. E. A. Stevens, State highway commissioner of New Jersey.
- Bulletin 17. The selection of materials for macadam roads. By Logan Waller Page, director U. S. Office of Public Roads.
- Bulletin 18. Concrete roads. By Hon. Frank F. Rogers, State highway commissioner of Michigan.
- Bulletin 19. Bituminous construction. By S. D. Foster, chief engineer Pennsylvania State highway commission.
- Bulletin 20. Educational field for highway departments. By Dr. Joseph Hyde Pratt, State geologist of North Carolina.
- Bulletin 21. Engineering supervision of road construction. By W. S. Keller, State highway engineer of Alabama.
- Bulletin 22. Road economics. By J. E. Pennybacker, chief of road economics, U. S. Office of Public Roads.
- Bulletin 23. State control of road work as a policy. By A. N. Johnson, chief engineer, bureau of municipal research, New York City.
- Bulletin 24. Rights of way. By Austin B. Fletcher, State highway engineer of California.
- Bulletin 25. Drainage structures. By W. E. Atkinson, State highway engineer of Louisiana.
- Bulletin 26. Grades and excavation. By A. D. Williams, chief engineer State roads commission of West Virginia.
- Bulletin 27. Light traffic roads. By S. Percy Hooker, State superintendent of highways of New Hampshire.

Bulletin 28. Selecting the roads to be improved.

By Fairfax Harrison, president, Southern Railway Company.

Bulletin 29. Heavy traffic roads.

By Henry G. Shirley, chief engineer, State roads commission of Maryland.

Bulletin 30. Maintenance of earth roads.

By George W. Cooley, State highway engineer of Minnesota.

Bulletin 31. Maintenance of surfaced roads.

By Col. William D. Sohler, chairman, Massachusetts highway commission.

Bulletin 32. System in road management.

By Charles J. Bennett, State highway commissioner of Connecticut.

Bulletin 33. Bituminous macadam by the cold mixing method.

By Irving W. Patterson, chief engineer, Rhode Island State board of public roads.

Bulletin 34. Convict labor.

By George P. Coleman, State highway commissioner of Virginia.

Note.—All publications are sent free to members of the association. The annual dues for membership are \$5.00, and cover a period of twelve months from date of payment. Remittance for either dues or publications should be made to John Burke, treasurer.

American Association of State Highway Officials

The purpose of this organization is to study the various materials for, and methods of construction and maintenance of, the roads of the United States; to exchange information and promote closer relations between State highway departments, with a view to establishing more uniform systems of legislation, administration, construction and maintenance respecting roads, so as to increase efficiency in the work and conserve the capital invested in highways; to cooperate in every possible way with the office of Public Roads and Rural Engineering and similar federal bureaus in the consideration of road problems.

Active membership is limited to State highway commissioners, chief engineers and other chief directing officials actively engaged in the administrative work of State highway departments or the United States government. Associate members are such assistant and deputy commissioners, assistant and resident engineers, and chief directing officials in the highway departments of other North American countries, as are proposed by active members.

Honorary members are former active members who cease to be eligible for the latter rank, and the professors of highway engineering in accredited universities. The annual dues are \$5 for active members, \$3 for associate members, and \$25 commutation fee for all active members in the highway department of any State.

The officers are selected from the active members and no State can be represented by more than one officer. There are four special standing committees, executive, finance, tests and investigations, and standards. The committee on tests and investigations is

instructed to confer with highway departments and similar committees of other organizations respecting tests and investigations of the value of different road materials. The committee on standards is instructed to coöperate with State and United States departments and other organizations in establishing standard types of construction and standard systems of maintenance.

President, Henry G. Shirley, Chief Engineer, Maryland State Roads Commission, Baltimore, Md.; vice-president, A. B. Fletcher, State Highway Engineer of California, Sacramento, Calif.; secretary, Dr. Joseph Hyde Pratt, State Engineer and Geologist of North Carolina, Chapel Hill, N. C.; treasurer, F. F. Rogers, State Highway Commissioner of Michigan, Lansing, Mich. Executive committee, G. P. Coleman, State Highway Commissioner of Virginia, Richmond, Va.; Col. Wm. D. Sohler, Chairman Massachusetts Highway Commission, Boston, Mass.; Thomas H. MacDonald, Highway Engineer, Iowa State Highway Commission, Ames, Iowa; Col. E. A. Stevens, State Road Commissioner of New Jersey, Trenton, N. J.; Lamar Cobb, State Engineer of Arizona, Phoenix, Ariz. Finance Committee, S. E. Bratt, secretary, Illinois State Highway Commission, Springfield, Ill.; W. S. Keller, State Highway Engineer of Alabama, Montgomery, Ala.; Paul D. Sargent, Chief Engineer, Maine State Highway Commission, Augusta, Me.; Edwin Duffey, State Highway Commissioner of New York.

American Automobile Association

Officers.—John A. Wilson, president, Franklin, Pa.; George C. Diehl, chairman good roads board, 575 Ellicott Square, Buffalo, N. Y.; A. G. Batchelder, chairman executive board, Riggs Building, Washington, D. C.

National Capitol Headquarters.—Riggs Building, Washington, D. C.

New York City Headquarters.—437 Fifth Avenue, New York.

American Concrete Institute

Officers.—Leonard C. Wason, President Aberthaw Construction Company, 27 School Street, Boston, Massachusetts, president; William K. Hatt, Professor of Civil Engineering, Purdue University, Lafayette, Indiana, vice-president; Henry C. Turner, President Turner Construction Company, 11 Broadway, New York City, vice-president; Robert W. Lesley, Pennsylvania Building, Philadelphia, Pennsylvania, treasurer; Walter S. Hynds, Atlas Portland Cement Company, 30 Broad Street, New York, secretary; Richard L. Humphrey, Consulting Engineer, Harrison Building, Philadelphia, Pennsylvania, past president.

American Road Builders' Association

Officers.—Col. E. A. Stevens, president, Trenton, N. J.; E. L. Powers, secretary, New York; W. W. Crosby, treasurer, Baltimore, Maryland.

Headquarters.—150 Nassau Street, New York.

American Society for Testing Materials

Officers.—Mansfield Merriman, president, 1071 Madison Ave., New York; Edgar Marburg, secretary-treasurer, University of Pennsylvania, Philadelphia, Pennsylvania.

Committees.—On Standard Specifications for Cement: George F. Swain, chairman, Harvard University, Cambridge, Massachusetts; Richard L. Humphrey, secretary, 805 Harrison Building, Philadelphia, Pennsylvania.

On Standard Specifications for Brick, Edward Orton, Jr., chairman, Ohio State University, Columbus, O.; A. V. Bleininger, 40th and Butler Streets, Pittsburgh, Pennsylvania.

On Standard Specifications and Tests for Clay and Cement Sewer Pipe: Rudolph Hering, chairman, 170 Broadway, New York; E. J. Fort, secretary, 215 Montague Street, Brooklyn, New York.

On Standard Tests and Specifications for Drain Tile: A. Marston, chairman, Iowa State College, Ames, Iowa.

On Standard Tests for Road Materials: Logan Waller Page, chairman, Office of Public Roads, Washington, D. C.; Prévost Hubbard, secretary, Office of Public Roads, Washington, D. C.

American Society of Civil Engineers

Officers.—E. L. Corthell, president; Charles Warren Hunt, secretary.

Headquarters.—220 West 57th Street, New York.

Purposes so far as they relate to roads.—Investigation and discussion of technical problems of road construction and maintenance.

American Society of Engineering Contractors

Officers.—President, Wm. P. Carmichael; first vice-president, John J. English; second vice-president, O. Lefebvre; secretary, J. R. Wemlinger, 44 Whitehall Street, New York; treasurer, G. A. Unverzagt.

Association of American Portland Cement Manufacturers

Officers.—President, B. F. Affleck, president Universal Portland Cement Co.; vice-presidents, F. W. Kelley, president Hel-

derberg Portland Cement Co., and Richard Hardy, president Dixie Portland Cement Co.; treasurer, G. S. Brown, president Alpha Portland Cement Co.; general manager, J. P. Beck.

Headquarters.—111 West Washington Street, Chicago, Ill.

Objects.—To acquire and disseminate information concerning the best practice in the use of cement and concrete.

To raise the standards of construction.

To emphasize the necessity of careful attention to all details of construction and to the selection of such materials as will produce the best results.

To give to anyone requesting same, information they may desire on the proper use of cement and concrete.

Association of State Highway Departments

Officers.—W. S. Gearhart, president, Manhattan, Kan.; John H. Mullen, secretary-treasurer, Schubert Building, St. Paul, Minn.

Canadian Highway Association

Officers.—Hon. Thomas Taylor, Minister of Public Works, B. C., honorary president; W. J. Kerr, president, New Westminster, B. C., Frank E. Mutton Toronto, Ontario, vice-president; P. W. Luce, New Westminster, B. C., secretary; T. S. Baxter, Vancouver, B. C., treasurer.

Purpose.—This organization is not actively concerned with the actual construction and improvement of roads, but work, is mainly along educational lines.

Canadian Society of Civil Engineers

Officers.—G. H. Duggan, Montreal, president; R. A. Ross, Montreal, A. St. Laurent, Ottawa; T. H. White, Vancouver, vice-presidents; E. Marceau, Montreal, treasurer; C. H. McLeod, Montreal, secretary.

Committee on Roads and Pavements.—W. A. McLean, Department of Public Highways, Parliament Buildings, Toronto, Ontario, Chairman.

Capital Highway Association

Officers.—Leonard Tufts, president, Pinehurst, N. C.; John R. McQueen, secretary, Pinehurst, N. C.

Farmers' National Congress

Officers.—H. E. Stockbridge, Atlanta, Ga., president; R. H. Kirby, Dallas City, Ill., vice-president; O. D. Hill, Kendall, W.

Va., secretary; D. K. Unsicker, Wright, Iowa, treasurer; John H. Kembell, Port Deposit, Md., legislative agent.

Federation of American Motorcyclists

Officers.—President, A. B. Coffman, 345 Ohio Building, Toledo, Ohio; secretary and treasurer, G. B. Gibson, Westboro, Mass.

Purposes.—Protesting against legislation discriminating against motorcyclists, legal aid in accident cases, protection against theft, encouragement of touring and supervision of racing.

Inter-Mountain Good Roads Association

Officers.—L. P. McCalla, Boise, Idaho, president; E. R. Margou, Salt Lake City, Utah, vice-president; T. H. Burton, Nephi, Utah, secretary-treasurer; the chairman of the Board of Commissioners of each county in the States of Utah, Idaho, Montana, Wyoming, Nevada and Colorado, is a vice-president.

International Association for Testing Materials

Officers.—Dr. Ing. N. Belebubsky, 14a Bronnitskaja, Petrograd, Russia, president; M. G. C. Lloyd, 28 Victoria Street, London, England, M. A. Mesnager, 182 Rue de Rivoli, Paris, France, Robt. W. Hunt, 2200 Insurance Exchange, Chicago, Ill., vice-presidents; Ernest Reitler, secretary-general, Nordbahnstrasse 50, Vienna, Austria.

Committee on Testing Materials for Roads.—M. A. Mesnager, president.

Lincoln Highway Association

Officers.—Henry B. Joy, Detroit, Mich., president; Carl G. Fisher, Indianapolis, Ind., vice-president; Roy D. Chapin, Detroit, Mich., vice-president; Austin F. Bement, secretary, Detroit, Mich.; Emory W. Clark, treasurer, Detroit, Mich.

Massachusetts Highway Association

Officers.—Louis K. Rourke, 8 Beacon Street, Boston, Mass., president; John M. Keyes, Concord, Mass., and John A. Williams, Framingham, Mass., vice-presidents; John M. McCarthy, 15 Ashburton Place, Boston, secretary; Charles A. Brown, Wellesly, Mass., treasurer; Charles J. Bennett, Hartford, Conn., Richard A. Jones, Waltham, Mass., Henry A. Spates, Winchester, Mass., and John A. Gaffey, Medford, Mass., directors.

National Association of Sand and Gravel Producers

Officers.—F. W. Renwick, Chicago Gravel Company, 343 S. Dearborn Street, Chicago, Illinois, president; H. M. Halliday, Halliday Sand Company, Cairo, Illinois, first vice-president; W. F. Bradley, Ohio and Michigan Sand and Gravel Company, Toledo, Ohio, second vice-president; H. F. Curtis, Lyman Sand Company, Omaha, Nebraska, third vice-president; Lee R. Witty, Wabash Sand and Gravel Company, Terre Haute, Indiana, fourth vice-president.

National Automobile Chamber of Commerce

Officers.—President, Charles Clifton; vice-president, Wilfred C. Leland; second vice-president, gasoline division, Hugh Chalmers; second vice-president, commercial vehicle division, Windsor T. White; second vice-president, electric vehicle division, H. H. Rice; secretary, R. D. Chapin; treasurer, George Pope; general manager, Alfred Reeves, 7 East 42d Street, New York.

National Conference on Concrete Road Building

Officers.—W. F. M. Goss, chairman; J. P. Beck, secretary, 111 West Washington Street, Chicago, Ill.

National Grange

Officers.—Oliver Wilson, master, Peoria, Ill.; E. E. Chapman, Ludlow, Mass., lecturer; C. M. Freeman, secretary, Tippecanoe City, Ohio. C. S. Stetson, chairman executive committee, Greene, Maine.

One of the Purposes.—The Grange is actively interested in the movement for better roads, particularly the movement for State and national legislation on the subject.

National Lime Manufacturers Association

Officers.—William E. Carson, president, Riverton, Virginia; Martin Deeley, first vice-president, Lee, Massachusetts; J. F. Pollock, second vice-president, Kansas City, Missouri; A. H. Laumen, third vice-president, Pittsburgh, Pennsylvania; Fred K. Irvine, secretary, Chicago, Illinois; C. W. S. Cobb, treasurer, St. Louis, Missouri.

Executive Committee.—W. E. Carson, chairman, ex-officio; Charles Warner, Wilmington, Delaware; Lawrence Hitchcock, Cleveland, Ohio; Bernard L. McNulty, Mitchell, Indiana.

National Rural Letter Carriers' Association

Officers.—George B. Kime, president, Willard, Missouri; Fred L. White, vice-president, Buckhead, Georgia; L. H. Wilson, secretary, Olivia, Minnesota; R. L. Cate, treasurer, Weatherford, Oklahoma; John R. Smith, Marshall, Michigan, L. M. Onyett, Fort Branch, Indiana, and S. A. Reynolds, Minter, Alabama, executive committee.

National Paving Brick Manufacturers Association

Officers.—C. C. Blair, president, Youngstown, Ohio; J. W. Robb, vice-president, Clinton, Indiana; C. C. Barr, treasurer, Streator, Illinois; Will P. Blair, secretary, Cleveland, Ohio; H. H. MacDonald, assistant secretary, Cleveland, Ohio. Executive Board, C. C. Blair, Charles J. Deckman and J. G. Barbour.

Purposes.—The National Paving Brick Manufacturers Association of this country was organized for the following purposes:

1. A dissemination among its membership of technical knowledge relating to the manufacture of their product.
2. To bring to the attention of the public the merits of Vitrified Brick as a paving material.
3. To influence to the greatest possible extent the proper construction of brick streets.
4. For furnishing truthful and reliable information regarding other paving materials, and their comparative value as pavements when considered with brick pavements.

New Santa Fe Trail Association

Officers.—O. M. Wilhite, Emporia, Kansas, president; C. H. Scott, Hutchinson, Kansas, secretary-treasurer; H. H. Taylor, Hutchinson, Kansas, official pilot.

New York State Road Builders Association

Officers.—John H. Gordon, Albany, New York, president; I. O. Cole, Rochester, New York, vice-president; Joseph W. Manion, Albany, New York, secretary; William G. Fox, Saratoga, New York, treasurer; John E. Johnson, Buffalo, New York, W. A. Greenfield, Hornell, New York, T. H. Gill, Boston, Massachusetts, Richard Hopkins, Troy, New York, and Thomas C. Brown, Schenectady, New York, trustees.

Northwestern Road Congress

Officer.—John A. Hazelwood, president, Jefferson, Wisconsin.

Quebec-Miami International Highway Association

Officers.—Howard D. Hadley, president, Plattsburgh, New York, George A. Simard, vice-president, care Franco-American Chemical Company, Montreal, P. Q., Canada; N. M. Parrott, secretary, 1204 Munsey Building, Baltimore, Md.

Ozark Trails Association

Officers.—President, W. H. Harvey, Monte Ne, Arkansas; vice-presidents, George Sengel, Fort Smith, Arkansas, J. I. Wolfe, Burlington, Kansas, E. J. Kling, Nevada, Missouri, Cyrus Avery, Tulsa, Oklahoma; secretary, Charles W. Fear, Joplin, Missouri; treasurer, Tom Cunningham, Joplin, Missouri; general manager for Missouri and Arkansas, Prof. W. A. Weltmer, Nevada, Missouri; general manager for Kansas, George Guernsey, Jr., Independence, Kansas.

Purpose.—To promote and mark connecting good roads in Arkansas, Kansas, Missouri and Oklahoma. About 600 miles of roads are now provided with markers. These markers are found to direct travel to the roads thus designated and make them main highways.

San Diego-Arizona Interstate Auxiliary of the Southern National Highway Association

Officers.—Ed. Fletcher, San Diego, president; William B. Gross, San Diego, secretary.

Santa Fe, Grand Canyon and Needles National Highway Association

Officers.—Carl G. Krook, Kingman, Arizona, president; E. F. Thompson, Kingman, Arizona, secretary; M. L. Powers, Flagstaff, Arizona, treasurer.

Society for the Promotion of Engineering Education

Officers.—H. S. Jacoby, Cornell University, Ithaca, New York, president; G. R. Chatburn, University of Nebraska, Lincoln, Nebraska; and F. H. Constant, Princeton University, Princeton, New Jersey, vice-presidents; F. L. Bishop, University of Pittsburgh, Pittsburgh, Pennsylvania, secretary; W. O. Wiley, 432 Fourth Avenue, New York City, treasurer; L. H. Harris, University of Pittsburgh, Pittsburgh, Pennsylvania, assistant secretary.

Southern Appalachian Good Roads Association

Officers.—Joseph Hyde Pratt, Chapel Hill, N. C., president and treasurer; C. B. Scott, Richmond, Va., secretary.

Southern Commercial Congress

Officers.—Duncan U. Fletcher, president; Clarence J. Owens, managing director; William H. Saunders, resident director, Chas. D. Douglas, general counsel.

Headquarters.—Southern Building, Washington, D. C.

Purposes.—Relating to road improvement. To encourage the movement for the construction of good roads and for the extension of railroad and trolley transportation.

Southern National Highway Association

Officers.—Colonel Dell M. Potter of Clifton, Arizona, president; Colonel Bennehan Cameron of Stagville, North Carolina, general vice-president; D. R. Ellis of Clifton, Arizona, secretary; and E. W. Jackson of San Diego, California, treasurer.

Texas, Arkansas and Louisiana Highway Association

Officer.—J. M. McHaney, president, Longview, Texas.

Travelers Protective Association of America

Officers.—C. F. Tomlinson, High Point, North Carolina, president; T. S. Logan, St. Louis, Missouri, secretary and treasurer.

Good Roads and Public Utilities Committee.—Dan W. Sale, Lynchburg, Virginia, chairman.

*State and Local Organizations**Alabama*

Alabama Good Roads Association. John Craft, president, Mobile.

Alabama Association of Highway Engineers, R. P. Boyd, president, Montgomery, Alabama.

Alabama Convict Improvement Association, J. A. Rountree, chairman, Birmingham.

Birmingham-Montgomery Highway Association, W. S. Keller, president, Montgomery; Barney M. Roberst, secretary, Clanton.

Montgomery-Lowndes-Dallas Highway Association, W. D. McCurdy, president, Lowndesboro; J. T. Jackson, secretary, Benton.

Decatur-Birmingham Highway Association, M. L. Robertson, president, Cullman, Ala.; J. D. Senig, secretary, Cullman, Ala.

Talladega-Montgomery Highway Association, Judge J. E. Camp, chairman, Talladega, Ala.

Florence-Tuscaloosa Highway Association, Judge E. B. Alman, president, Tuscumbia, Ala.

Calhoun County Good Roads Association, W. T. Goodlet, secretary, Jacksonville.
 Clarke County Good Roads Association, A. B. Tucker, president, Thomasville.
 Colbert County Good Roads Association, J. E. Isbell, president, Tuscumbia.
 Dallas County Good Roads Association, Clifton Kirkpatrick, president, Cahaba.
 Elmore County Good Roads Association, H. H. Golson, secretary, Wetumpka.
 Etowah County Good Roads Association, W. P. Archer, president, Gadsden, J. L. Irving, secretary, Gadsden.
 Franklin County Good Roads Association, J. Gassier, president, R. F. D. Russellville; J. C. Norwood, secretary, Russellville.
 Henry County Good Roads Association, Hon. J. R. Ward, president, Abbeville.
 Houston County Good Roads Association, W. R. Flowers, president, Dothan.
 Jefferson County Good Roads Association, John W. O'Neill, president, Birmingham; J. A. Rountree, secretary-treasurer, Birmingham.
 Lauderdale County Good Roads Association, Florence.
 Madison County Rural Letter Carriers' Association, Arthur P. Dean, president, Huntsville.
 Talladega County Good Roads Association, A. L. McElderry, president, Talladega.

Arizona

Arizona Good Roads Association, T. G. Norris, president, Prescott; M. A. Fraser, secretary, Prescott.
 Northern Arizona Good Roads Association, E. F. Thompson, secretary, Kingman.
 Borderland Route Association, J. F. Myers, president, Tucson; J. F. Gray, secretary.
 Warren District Club, Good Roads Committee, John J. Bowen, chairman, Bisbee.
 Mohave County Good Roads Association, Carl G. Krook, president, Kingman; E. F. Thompson, secretary-treasurer.

Arkansas

Arkansas Good Roads and Drainage Association, C. M. Philpot, president, Pine Bluff.
 Little Rock-Texarkana Highway Association, W. Y. Foster, president, Hope.
 Crawford County Roads Association, Dr. J. E. Blakemore, president, Van Buren.
 Northeast Arkansas and Southeast Missouri Good Roads Association, W. E. Spence, president, Piggott, Ark.; C. W. Highfill, secretary, Paragould, Ark.
 Ozark Trails Association, W. H. Harvey, president, Monte Ne, Ark.
 Sharp County Good Roads Association, Thomas J. Wood, president, Evening Shade.
 St. Francis County Branch of Memphis-Little Rock Highway Association, James Scott, president, Forrest City.
 Washington County Good Roads Association, C. E. Pritchard, president, Fayetteville.
 Woodruff County Good Roads Association, T. L. Gardner, Augusta.

California

Amador County Good Roads Association, C. E. Jarvis, secretary, Jackson, Calif.

Inyo County Good Roads Club, W. L. Scott, Terminal Hotel, San Francisco, Calif.; Dr. G. B. Doyle, president, Bishop, Calif.
 Napa County Good Roads Association, F. A. Golds, president, Napa, Calif.; E. W. Bendley, secretary, Napa, Calif.
 Sonoma County Good Roads Club, D. D. Wagers, secretary, Santa Rosa, Calif.
 Tulare County Highway Association, W. P. Boone, secretary, Visalia, Calif.

Colorado

Arkansas, Rio Grande, Gunnison & Grande River Highway Association, C. R. McLain, president, Canon City.
 Central Colorado Highway Association, L. E. Curtis, president, Colorado Springs.
 Colorado Good Roads Convention, L. E. Curtis, president, Colorado Springs; W. H. Emmons, secretary, Chamber of Commerce Building, Denver.
 Colorado Road Builders Association, R. H. Higgins, president, Pueblo; E. E. Sommers, vice-president, Denver; T. W. Monell, secretary-treasurer, Montrose.
 Arapahoe County Good Roads Association, Littleton.
 El Paso County Good Roads Association, Colorado Springs.
 Fremont County Good Roads Association, Canon City.
 Jefferson County Good Roads Association, Golden.
 La Plata County Good Roads Association, Chamber of Commerce, Durango.
 Las Animas County Good Roads Association, Trinidad.
 Lincoln Highway Association of Colorado, Leonard E. Curtis, president, Colorado Springs, Colo.; R. E. Lee Giles, secretary-treasurer, Manitou, Colo.
 Park County Good Roads Association, Fairplay.
 Pitkin County Good Roads Association, Aspen.
 Prowers County Good Roads Association, Holly.
 Rio Blanco County Good Roads Association, Meeker.
 San Juan County Good Roads Association, Chamber of Commerce, Silverton.
 Weld County Good Roads Association, Ault & Greeley.

Connecticut

Association of Connecticut Road Builders, Hartford, Alfred H. Terry, president, Bridgeport; Robert E. Mitchell, vice-president, Williamantic; R. J. Rose, secretary-treasurer, Hartford.
 Connecticut Good Roads Association, 902 Chapel St., Room 701, New Haven, Henry A. Bishop, president, Bridgeport; Don C. Seitz, 1st vice-president, Greenwich; Wallace F. Fenn, 2d vice-president, Hartford; George W. Eames, 3d vice-president, Bridgeport; Philip Bond, treasurer, New Haven; Charles Marcy Robinson, secretary, New Haven.
 Connecticut Road Officials Association, Alfred H. Terry, president, Bridgeport; R. J. Ross, Secretary-treasurer, Hartford; W. E. Kennedy, vice-president, Waterbury.
 Fairfield County: Redding Protective League, Dan Beard, chairman, Redding; Charles H. Plump, secretary, Redding; J. B. Sanford, treasurer, Redding.
 New Haven County: Waterbury Good Roads Association, George Tracy, president, Waterbury; W. B. Reynolds, secretary, Waterbury; F. C. Peabody, treasurer, Waterbury.

Delaware

Delaware Good Roads Association, Laurel, Delaware.

Georgia

- Atlantic & Gulf Highway Association, Dr. G. P. Folks, president, Waycross;
C. Fort Andrews, secretary, Waycross.
- Battlefield Route Association, George A. Veach, president, Adams Park;
W. H. Field, secretary, Cartersville.
- Central Route Association, Capt. H. H. Tift, president, Tifton.
- Georgia-Alabama Good Roads Association, F. C. Lumpkin, president,
Columbus.
- Georgia Federation of Road Authorities, Wm. F. Eve, president, Augusta.
- Georgia Good Roads Club, Fred. L. White, president, Buckhead.
- North Georgia Good Roads Association, A. N. Tumlin, president, Cave
Springs.
- South Georgia Good Roads Association, L. V. Williams, president, Way-
cross; C. F. Andrews, secretary, Waycross.
- Georgia Carolina Good Roads Association, E. J. Watson, president, Colum-
bia, S. C.
- Columbus. Harris County & Pine Mountain Good Roads Association.
R. L. Baldwin President, Waverly Hall, Georgia.
- Georgia Association of County Road Commissioners, W. T. Winn, presi-
dent, Atlanta, Ga.; Fred Houser, secretary, Atlanta, Ga.
- North Georgia Good Roads Association, A. N. Tumlin, president, Cave
Springs, Ga.
- Chattahoochie County Good Roads Association, F. G. Lumpkin, presi-
dent; L. J. Henderson, secretary, Columbus, Ga.
- Appling County Good Roads Association, W. H. Tilman, president, Sur-
renry.
- Ben Hill County Good Roads Club, J. G. Knapp, president, Fitzgerald.
- Berrien County Good Roads Association, Danl. McCraney, president,
Sparks.
- Brooks County Highway Improvement Association, H. W. Stubbs, presi-
dent, Quitman.
- Butts County Good Roads Association, S. J. Smith, president, Jackson.
- Charlton County Good Roads Association, P. T. Osterman, president,
St. George.
- Clarke County Good Roads Association, Martin J. Abney, president,
Athens.
- Clinch County Good Roads Association, J. T. Dame, president, Homer-
ville.
- Crawford County Good Roads Association, S. H. Phelan, president,
Roberta.
- Crisp County Good Roads Association, Dr. T. J. McArthur, president,
Cordele.
- Dodge County Good Roads Association, Sol Herrman, president, Eastman.
- Dooly County Good Roads Association, J. O. Heard, president, Vienna.
- Douglas County Good Roads Association, A. S. Gresham, president, Doug-
lassville.
- Elbert County Good Roads Association, L. M. Brown, president, R. F. D.
3, Elberton.
- Fayette County Good Roads Association, A. O. Bloblock, president, Fay-
etteville.
- Glascock County Good Roads Association, Albert Logue, president, Gibson.
- Glynn County Good Roads Association, Albert Fendig, president, Bruns-
wick.
- Grady County Good Roads Association, W. B. Roddenberg, president,
Cairo.
- Greene County Good Roads Club, W. P. McWhorter, president, Woodville.

Habersham County Good Roads Association, John Martin, president, Clarkesville; W. S. Irwin, secretary, Clarkesville.
 Hall County Good Roads Association, J. M. Mundy, president, Gainesville.
 Hart County Good Roads Association, L. S. Brown, president, Hartwell.
 Houston County Good Roads Association, J. L. Fincher, president, Ft. Valley.
 Jeff Davis County Good Roads Association, N. L. Hatten, Hazelhurst.
 Jefferson County Good Roads Association, W. J. Wrens, president, Wrens.
 Jackson County Good Roads Association, W. C. Davis, president, Commerce.
 Liberty County Good Roads Association, Dr. D. W. Baggs, president, Ludowici.
 Meriweather County Good Roads Association, J. M. Barnes, president, Bullochville.
 Monroe County Good Roads Association, Col. J. O. Parsons, president, Forsyth.
 Newton County Good Roads Club, L. W. Jarman, president, Porterdale; J. H. Echols, secretary, Covington.
 Ninth Ward and West DeKalb Good Roads Improvement Club, A. S. Hock, president, Kirkwood.
 Pierce County Good Roads Association, L. W. Root, president, Blackshear.
 Piedmont Highway Association, Wm. Eberhart, president, Cornelia.
 Pike County Good Roads Association, W. A. Strickland, president, Concord.
 Pulaski County Good Roads Association, T. D. Walker, president, Cochran.
 Rabun County Good Roads Association, A. J. Duncan, president, Clayton.
 Richmond County Good Roads Association, D. C. Haynes, president, Augusta.
 Spalding County Good Roads Association, Hon. Roswell H. Drake, president, Griffin.
 Taylor County Good Roads Association, W. D. Steed, president, Butler.
 Telfair County Good Roads Association, Capt. T. J. Smith, president, McRae.
 Tift County Good Roads Association, Capt. H. H. Tift, president, Tifton; W. E. Farmer, secretary, Tifton.
 Turner County Good Roads Association, J. S. Shingler, president, Ashburn.
 Upson County Good Roads Association, O. B. Clements, president, Yatesville.
 Ware County Good Roads Association, Dr. G. P. Folks, president, Waycross.
 Washington County Good Roads Association, C. H. Shephard, president, Tennille.
 Wayne County Good Roads Association, W. J. Broadhurst, president, Jesup.

Illinois

Illinois Bankers Association, S. E. Bradt, chairman, DeKalb.
 Illinois Commercial Federation, C. A. Kiler, chairman, Champaign.
 Illinois Official Trans-Continental Route Association, Geo. E. Stocking, president, Rochelle; S. F. Durga, secretary, DeKalb.
 Illinois Highway Improvement Association, Wm. G. Edens, president, Central Trust Co., Chicago; R. J. Finnegan, secretary, 15 South Market St., Chicago.
 Bureau County Road Improvement Association, C. O. Brigham, president, Princeton; K. B. Seibel, secretary, Princeton.
 Clark County: Casey Good Roads Club, W. M. Abraham, secretary, Casey.
 Cumberland County National Road Association, P. J. Bowman, president, Greenup; E. M. Eckard, secretary, Greenup.

DeKalb County: Waterman Cooperative Good Roads League, Dr. C. H. Wilkenson, president, Waterman; W. T. Wiltberger, secretary, Waterman.
 Effingham County Good Roads Association, A. D. McCallen, president, Effingham.
 Effingham Good Roads Club, J. H. Curry, secretary, Effingham.
 Henry County: Galva Good Roads Improvement Association, John Miller, chairman, Galva.
 Jo Daviess County: Progressive Good Roads Club, Dr. D. G. Smith, president, Elizabeth; C. A. Walters, secretary, Elizabeth.
 Macoupin County: Betsey Ann Association Inc., H. A. Heidemann, president, Brighton; Irvin M. Clark, secretary, Brighton.
 Randolph County Good Roads Association, L. H. Paulter, Evansville.
 Rock Island County: Black Hawk Good Roads Association, D. W. Matthews, president, Milan.
 Rock Island County: Highway Improvement Association, E. W. Woodcock, secretary, Moline.
 St Clair County: Good Roads Cooperative League, G. G. Book, president, Smithton.
 Washington County Good Roads Association, W. O. Weihs, president, Nashville.

Indiana

Good Roads Association, T. L. Wheeler, secretary, Huntington.
 Indiana Association of County Commissioners & County Attorneys, Indianapolis.
 Indiana Federated Commercial Clubs, Good Roads Committee, L. H. Lewis, secretary, Indianapolis.
 Indiana Good Roads Association, C. A. Kenyon, president, Meridian Life Building, Indianapolis.
 Indiana Letter Carriers' Association, Good Roads Committee, W. J. Ward, chairman, Carmel.
 Northern Indiana Good Roads Association, Aaron Jones, president, South Bend; C. E. Craybill, secretary, South Bend.
 Clark County: Fayette Township Good Roads Association, John Loesch, secretary, Floyd Knobs.
 Hendricks County: Plainfield Improvement League, Dr. Amos Carter, president, Plainfield.
 Jefferson County Good Roads Association, John McGregor, president, Madison.
 Carroll County: Delphi Branch Indiana Good Roads Association, James B. Engles, secretary, Delphi, Ind.
 Dekalb County: Auburn Branch Indiana Good Roads Association, W. H. Willenar, president, Auburn, Ind.; W. H. Schaab, secretary, Auburn, Ind.
 Delaware County: Muncie Branch Indiana Good Roads Association, Harry L. Kitselman, president, Muncie, Ind.
 Hamilton County: Noblesville Branch Indiana Good Roads Association, Newton W. Cowgill, secretary, Noblesville, Ind.
 Johnson County: Franklin Branch Indiana Good Roads Association, Robert A. Brown, president, Franklin, Ind.; Robert W. Wilson, secretary, Franklin, Ind.
 Greenwood Branch Indiana Good Roads Association, H. A. Craig, president, Greenwood, Ind.; S. E. Wright, secretary, Greenwood, Ind.
 Lake County: Hammond Branch Indiana Good Roads Association, A. M. Turner, president, Hammond, Ind.
 Morgan County: Martinsville Branch Indiana Good Roads Association, Odin R. Smith, president, Martinsville, Ind.; O. C. Toner, secretary, Martinsville, Ind.

Mooreville Branch Indiana Good Roads Association, D. B. Johnson, president, Mooreville, Ind.; Geo. I. Reeves, secretary, Mooreville, Ind.

Stauben County: Angola Branch Indiana Good Roads Association, F. A. Emerson, president, Angola, Ind.; Cary E. Covell, secretary, Angola, Ind.

Idaho

Ada County Good Roads Association, K. P. McCalla, president, Boise, Idaho.

Blaine County Good Roads Association, Earl Fox, president, Hailey, Idaho.

Canyon County: Nampa Highway District, O. G. Reinhardt, president, Nampa, Idaho.

Fremont County: Upper Snake River Good Roads Association, Mark Austin, president, Rexburg, Idaho.

Idaho County Good Roads Association, Grangeville, Idaho.

Iowa

Ayr Line Association, Albert I. Smith, president. Mount Ayr; H. C. Beard, secretary, Mount Ayr.

Blue Grass Road, Joe L. Long, president, Des Moines.

Cannon Ball Trail, Robert Carson, Iowa City.

Corn Belt Highway, F. L. Hall, Secretary, Weldon.

Council Bluffs, Sioux City & Spirit Lake Highway Association, Frank Patch, president, Hartley.

Des Moines-Fort Dodge & Spirit Lake Highway Association, J. F. Ford, secretary, Fort Dodge.

Des Moines Thresher Club, W. L. Trueblood, president, Des Moines.

"Great White Way", Toy A. Stacy, secretary, Adair.

Hawkeye Highway, Dr. H. M. Bradley, secretary, Manchester.

Inter-State Trail Association, W. A. Hopkins, Lamoni.

I-O-A Short Line, Chas. F. Walling, president, Oskaloosa.

Iowa Good Roads Association, Lafayette Young, Sr., president, Des Moines; Thos. H. MacDonald, secretary, Ames.

Iowa Official Transcontinental Route (Lincoln Memorial Highway), W. F. Haskell, president, Cedar Rapids; W. C. Rollins, secretary, Denison.

Iowa State Quarrymen's Association, James W. Burroughs, secretary, Marshalltown.

North Iowa Pike Association, Wm. Hathorn, secretary, Mason City.

River-to-River Road Association, Bert N. Mills, secretary, Des Moines.

Waubensie Trail, U. G. Reininger, president, Sioux Falls, S. D.

Adams County: Prescott Community Improvement Club, H. M. Stanley, secretary, Prescott.

Black Hawk County Good Roads Club, F. A. Ferguson, president, Waterloo.

Buena Vista County: Storm Lake-Okobogi Air Line, Scott Bradford, president, Storm Lake.

Lee County: Fort Madison First Association, S. Atlee, president, Ft. Madison; J. R. Frailey, secretary, Ft. Madison.

Lucas County: Russell Boulevard Association, Algmer J. Allen, president, Russell.

Guthrie County: Panora Speedway Association, W. G. Roberts, Panora, Iowa.

Montgomery County Highway Commission, H. M. Howard, Red Oak, Iowa.

Kansas

Kansas State Good Roads Association, O. M. Wilhite, president, Emporia; G. J. Hinshaw, secretary, Newton.

Kansas Engineering Society, J. M. Meade, president, Topeka; T. J. Strickler, secretary-treasurer, Topeka.
Meridian Road Association, John C. Nicholson, president, Newton.
Kansas Division, W. W. Watson, president, Salina; S. E. Jackman, secretary, Minneapolis.
Old Santa Fe Trail, T. W. Whiting, president, Council Grove; Frank A. Davis, secretary, Herington.
Golden Belt Road Association, C. M. Harger, president, Abilene; George Caldwell, secretary, Salina.
Sunflower Trail, R. M. Anderson, president, Beloit; L. A. Mergen, secretary, Beloit.
Oil Belt Route, H. W. Loy, president, Chanute; Herbert Cavaness, secretary Chanute.
Tri-State Trail, H. O. Douglass, president, Oberlin; Chas. Sawyer, secretary-treasurer, Norton.
The New Santa Fe Trail, R. H. Faxon, president, Garden City; C. H. Scott, secretary-treasurer, Hutchinson.
Rock Island Highway, C. W. Cole, president, Newton; A. Q. Miller, secretary-treasurer, Belleville.
Atchison County Good Roads Association, A. S. Drury, president, Atchison; Alva Clapp, secretary, Atchison.
Cloud County Good Roads Association, P. G. Harmon, secretary-treasurer, Concordia.
Geary County Good Roads Association, Dr. W. S. Yates, president, Junction City; O. E. Hutchings, secretary-treasurer, Junction City.
Graham County Good Roads Association, William Burns, president, Bogue; D. C. Green, secretary, Hill City.
Montgomery County Good Roads Association, H. G. James, president, Independence; Sam L. McMurtry, secretary, Independence.
Cherryvale Good Roads Association, H. M. Casebeer, president, Cherryvale; F. D. Moffett, secretary-treasurer, Cherryvale.
Nemaha County: Goff Improvement Association, Chas. A. Richard, president, Goff; E. F. Holstone, secretary, Goff.
Shawnee County Good Roads Association, A. E. McGregor, president, Washington.
Linn Good Roads Association, Henry Meierkord, secretary-treasurer, Linn.
Red Line Road Association, L. F. Davidson, president, Glasco, Kans.; W. F. Hughes, secretary, Plainville, Kans.
Canada, Kansas City and Gulf Road Association, F. O. Peiper, president, Paola, Kans.; Oscar Rice, secretary, Fort Scott, Kans.
National Old Trails Road Association, T. W. Whiting, president, Council Grove, Kans.; W. H. Mott, secretary, Herington, Kans.
Solomon Valley Highway Association, J. Q. Adams, president, Stockton, Kans.; I. R. Mort, secretary-treasurer, Hill City, Kans.
The Kansas White Way, B. F. Morgan, president, Clay Center, Kans.; J. Q. Adams, secretary, Stockton, Kans.
Neosho Valley Good Roads Association, M. A. Limbocker, president, Burlington, Kans.; S. D. Weaver, secretary-treasurer, Burlington, Kans.
Corn Belt Road Association, M. S. McCreight, president, Oskaloosa, Kans.; Dr. Watkins, secretary, Tonganoxie, Kans.
Eastern Kansas Good Roads Association, J. Frank Smith, Pleasanton, Kans.; W. P. Conkey, secretary, Pleasanton, Kans.

Kentucky

Kentucky Good Roads Association, R. J. McBride, president, Louisville Times, Louisville; R. C. Terrell, secretary, Frankfort.

Kentucky County Road Engineers Association. Guthrie Wilson, president, Bardstown, Ky.; R. C. Terrell, chairman executive committee, Frankfort, Ky.; J. G. Baxter, secretary, Richmond, Ky.; J. F. Grimes, secretary executive committee, Frankfort, Ky.

Breathitt County Good Roads Club, South Strong, president, Jackson, Ky.; Alfred Russell, secretary, Jackson, Ky.

Knott County Good Roads Club, Judge R. M. Amburgy, president, Hindman, Ky.; John M. Baker, secretary, Hindman, Ky.

Leslie County: Wooten Good Roads Club, W. M. Dixon, president, Wooten, Ky.; Chester Dixon, secretary, Wooten, Ky.

Leslie County Good Roads Club, Judge T. G. Lewis, president, Hyden, Ky.; R. L. Dixon, secretary, Hyden, Ky.

Letcher County Good Roads Club, Judge H. T. Day, president, Whitesburg, Ky.; L. E. Hawie, secretary, Whitesburg, Ky.

Perry County Good Roads Club, Judge J. G. Campbell, president, Hazard, Ky.; Rebel Martin, secretary, Hazard, Ky.

Southern Kentucky Good Roads Association. N. R. Patterson, president, Pineville; Miss Lena Rollins, secretary, Pineville, George H. Reese, treasurer, Pineville.

Breckenridge County Good Roads Association, W. J. Piggott, president, Irvington, Mrs. R. B. McGlothlan, secretary, Irvington.

Crittenden County: Good Roads Committee, Carl Henderson, president, Marion; G. T. Belt, secretary, Sheridan.

Henry County Citizens League, Park C. Smith, president, Smithfield; E. A. Gullion, secretary, New Castle.

Hopkins County Road Association, J. F. Gordon, president, Madisonville; G. W. Sybert, secretary, Madisonville.

Kenton County Good Roads Association, W. L. White, secretary, R.F.D. 1, Latonia.

Knox County: Boone Way Booster Band, J. T. Stamper, president, Barbourville; W. H. McDonald, secretary.

Larue County: Central Lincoln Road Club, Dr. J. C. Jones, president, Buffalo; W. G. Desarn, secretary-treasurer, Hodgenville.

McCracken County: Joint Committee of Board of Trade Retail Merchants Association, and Automobile Club, B. Weille, chairman, Paducah.

Paducah Road Association, C. W. Craig, president, Paducah; Ben Willis, secretary, Paducah.

Glade District Good Roads Association, John L. Gay, president, Berea.

Nelson County: Good Roads Association (Bloomfield,) Guthrie Wilson, secretary, Bardstown.

Rockcastle County: Boone Way Booster Band, W. H. Fish, president, Mt. Vernon; James Maret, secretary-treasurer, Mt. Vernon.

Rowan County Good Roads Association, S. M. Bradley, president, Morehead; B. S. Wilson, secretary, Morehead; H. H. Caudill, treasurer, Morehead.

Todd County Good Roads Association, George Snadon, chairman, Guthrie; George Weathers, secretary, Elkton.

Warren County Good Roads Association, Dr. Jos. N. McCormack, president, Bowling Green.

Whitley County Good Roads Organization, S. Stanfill, chairman, Williamsburg; H. C. Gillis, secretary.

Louisiana

Louisiana Good Roads Association, P. M. Milner, president, Hibernia Bank Bldg., New Orleans, La.; W. E. Atkinson, ex-officio vice president, State highway engineer, New Orleans, La.; nine vice-presidents, one from each congressional district.

Allen Parish Good Roads Association, Dr. M. V. Hargrove, president, Oakdale, La.
 St. Tammany Parish: Good Roads Committee, E. J. Domerque, Jr., chairman, Covington, La.; R. L. Aubert, secretary, Covington, La.
 Baton Rouge-New Orleans Good Roads Association, F. B. McQuesty, secretary, Baton Rouge.
 Acadia Parish Good Roads Association, H. E. Lewis, president, Crowley.
 Calcasieu Parish Good Roads Association, Dr. J. M. Ways, president, Kinder.
 Iberia Parish Good Roads Association, Dr. Guy Shaw, president, Loreauville.
 Ouachita Parish: East Side Road Committee, Victor C. Barringer, secretary, Monroe.
 St. Landry Parish Good Roads Association, Jas. O. Chachere, president, Opelousas.

Maine

Aroostook County Good Roads Association, Howard W. Safford, president, Mars Hill; Michael M. Clarke, secretary, Houlton.
 Knox County Automobile & Good Roads Association, A. S. Littlefield, president, Rockland.
 Piscataquis County Good Roads Association, E. E. Whitney, president, Dover; C. E. Kimball, secretary-treasurer, Dover.
 Kennebunk Good Roads Association, Dr. Frank M. Ross, president, Kennebunk; Frank W. Bonser, secretary.

Maryland

Baltimore County Good Roads Association, J. Frank Shipley, president, Gwynbrook; D. Frank Shamberger, secretary, 1507 McCulloh St., Baltimore.
 Baltimore Engineers' Club, J. H. Milburn, c/o B. & O. R. R. Co., president; Baltimore, H. C. Williar, secretary, c/o Paving Commission, Baltimore.
 Arlington Improvement Association, Chas. T. Cockey, Jr., president, Arlington.
 Belair Road Improvement & Protective Association, Dr. A. L. Wilkinson, president, Raspeburg.
 Central Park Improvement Association, R. H. Williams, president, 619 Gaither building, Baltimore.
 Catonsville Neighborhood Improvement Association, John Hubner, president, Catonsville.
 East Arlington Improvement Association, Chas. Goldeisen, president, Arlington.
 Govans Improvement Association, Dr. E. M. Duncan, president. Govans.
 Good Roads Association, Major John I. Yellott, president, Towson.
 Green Spring Park & Pimlico Road Improvement Association, Wm. G. Henkel, president, 1021 Light Street, Baltimore.
 Halethorpe Protective & Improvement Association, Dr. Fred V. Beitler, president, Halethorpe.
 Hamilton Improvement Association, William McCallister, president, Hamilton.
 Hayward Improvement Association, W. O. Smith, president, Arlington.
 Hebbville Improvement Association, Wm. F. Piel, Jr., president, Hebbville.
 Hereford Improvement Association, Dr. Fred G. Mitchell, president, Glencoe.
 Hillsdale Improvement Association, E. S. Hutton, president, Hillsdale.
 Howard Park Improvement Association, Louis Moller, president, 111 Light St., Baltimore.

Lansdowne Improvement Association, J. D. W. Lindquist, president, Lansdowne.
 Lauraville Improvement Association, Frederick Evans, president, Lauraville.
 Lutherville Improvement Association, J. Robert Wood, president, Lutherville.
 Marble Hill Improvement Association, George Jessup, president, Cockeysville.
 Mt. Washington Improvement Association, Frank J. LaMotte, president, Mt. Washington.
 Orangeville Improvement Association, M. P. Ebaugh, president, Orangeville.
 Park Heights Pimlico and Arlington Improvement Association, John Trainor, president, 877 N. Howard St., Baltimore.
 Parkville Improvement Association, Thomas F. Mallonee, president, Parkville.
 Pikeville Improvement Association, W. E. Lovering, president, Pikeville.
 Relay Improvement Association, J. A. Baldwin, president, Relay.
 Roland Park Civic League, Dr. Paul Haupt, president, Roland Park.
 Towson Improvement Association, John I. Yellott, president, Towson.
 Upper Falls Improvement Association, Edward Reynolds, president, Upper Falls.
 Windsor Hills Improvement Association, Rev. W. A. Crawford Frost, president, Windsor Hills.
 Chase Improvement Association, H. E. Brazier, president, Chase.
 Neighborhood Association of Highlandtown and Canton, Townley R. Wolfe, president, 3518 Bank St., Baltimore.
 Rockdale Improvement Association, H. E. Hough, president, Raspeburg.
 St. Helena Improvement Association, Harry Marchant, president, St. Helena.
 Woodlawn Improvement Association, G. L. Ellis, president, 316 W. Mulberry St., Baltimore.
 Cecil County: Committee on Repair and Maintenance of Roads, S. G. England, R. H. Logan, Joseph T. Graves, all of North East, Md.
 Harford County Road League, J. W. Davis, secretary, Rocks, Md.
 Cecil County Farmers' Civic and Business Association, W. R. Cameron, president, Rising Sun; Mr. Briggs, secretary, North East.
 East New Market Improvement Association, Chas. Webster, president, East New Market; W. A. Percy, secretary, Vienna.

Massachusetts

Massachusetts Highway Association, Louis K. Rourke, president, Boston; John M. McCarthy, secretary, 15 Ashburton Place, Boston.
 Essex County Associated Boards of Trade, Committee on Highways, John F. Browning, chairman, 418 Lafayette St., Salem.
 Hampden County Improvement League, Horace A. Moses, president, Russell; John A. Scheuerle, general secretary, Massasoit Building, Springfield.

Michigan

Michigan Good Roads Association, P. T. Colgrove, president, Hastings; A. A. Anderson, secretary, Hastings.
 Northeastern Michigan Development Bureau, Vet S. Maloney, president, Cheboygan; T. F. Marston, secretary-manager, Bay City.
 Western Michigan Development Bureau, D. H. Day, president, Glen Haven; John I. Gibson, secretary, Traverse City.

Lake Huron Shore Good Roads Association, J. R. Snody, president, Onaway; John Simmons, secretary, Alpena; road commissioner, H. K. Gustin, Alpena.
West Michigan Pike Association, Dr. Wm. DeKleine, president, Grand Haven; Richard M. Hoffman, secretary-treasurer, Manistee.
Western Michigan Lakeshore Highway Association, Lee H. Trott, president, Muskegon; William De Kleine, secretary, Grand Haven.
Trunk Highway Association, W. F. Johnson, secretary, Roscommon.
Berrien County Good Roads Association, J. M. Ball, president, St. Joseph; I. W. Allen, secretary, St. Joseph.
Montcalm County: Stanton Good Roads Association, M. W. Stevenson, president, Stanton; D. A. Towle, secretary, Stanton.
Sheridan Good Roads Association, C. H. Clement, president, Sheridan; A. E. Stebbins, secretary, Stebbins.
Wexford County Good Roads Association, D. B. Kelley, president, Cadillac; Henry Knowlton, secretary, Cadillac.

Minnesota

Minnesota Road Makers' Association, John H. Mullen, secretary, St. Paul.
State Highway Association, Geo. W. Cooley, secretary, St. Paul.
Aitkin County: Aitkin Development Association, Mr. Warner, president, Aitkin.
Brown County: Springfield Good Roads and Development Association, Springfield.
Carlton County Development Association, Carlton.
Crow Wing County: Northern Development Association, C. A. Albright, president, Crow Wing.
Hennepin County: Minneapolis Civic and Commerce Association, Douglas A. Fiske, president, Minneapolis; Howard Strong, secretary, Minneapolis.
LeSuer County: Elysian Good Roads Association, C. Gologan, president, Elysian.
LeSuer Good Roads Association, Oscar Swenson, president, Le Suer.
New Prague Good Roads Association, J. F. Wraybeck, secretary, New Prague.
Nicollet County Good Roads Association, A. J. Potts, president, Nicollet.
Rice County: Lonsdale Good Roads Association, A. J. Smisek, president, Lonsdale.
Scott County Good Roads Association, J. H. Moore, president, Jordan; J. G. Casey, secretary, Jordan.
Steele County: Good Roads Association, Fred Jurgenson, secretary, Blooming Prairie.
Waseka County: Janesville Good Roads Association, Mr. Bardon, president Janesville.
New Richland Good Roads Association, M. A. Hodgkins, president, New Richland.
Waseka Good Roads Association, Dr. Blanchard, president, Waseka.

Mississippi

State Highway Association, C. C. Dunn, president, Corinth; M. L. Bipler, secretary, Biloxi.
Adams County Good Roads Committee, P. W. Mulverhill, secretary, Natchez.
Alcorn County: Good Roads Association, R. L. Young, president, Corinth; W. D. Striplin, secretary, Corinth.

Chickasaw County Good Roads Committee, J. S. Rowe, chairman, Okolona;
F. M. Elliott, secretary, Okolona.
Coahoma County: Good Roads Association, H. H. Hopeon, chairman,
Clarksdale; F. G. Wingfield, secretary, Clarksdale.
Forest County Good Roads Commission, J. K. Denham, chairman, Hattiesburg.
Harrison County Road Association, J. H. Long, president, Pass Christian;
M. P. Bouslog, secretary, Gulfport.
Harrison County: Good Roads Committee, G. W. Grayson, president,
Biloxi; S. M. Tracy, secretary, Biloxi.
Hinds County: Executive Committee, East and West Highway Association,
Edgar S. Wilson, chairman, Jackson.
Lauderdale County Road Association, W. P. Moore, Engineer, Meridian.
Lincoln County Highway Commission, H. Cassidy, president, Brookhaven;
Estus Smith, secretary, Brookhaven.
Marshall County Road Committee, W. B. Bradberry, president, Holly
Springs; John E. Anderson, secretary, Holly Springs.
Montgomery County Road Commission, Henry Hart, chairman, Winona.
Newton County: Good Roads League, W. V. Fant, president, Newton.
Warren County Road Association, J. W. Tucker, president, Vicksburg;
J. H. Adams, secretary, Vicksburg.
Yasoo County Road Association, E. L. Tarry, secretary, Yasoo City.

Missouri

Cannon Ball Trail Association, Jas. R. Bowsher, president, Leon; Chas. D.
Davis, secretary, Princeton.
Capitol Route State Highway Association, J. H. Bothwell, president,
Sedalia; M. V. Carroll, secretary, Sedalia.
Highway Engineers Association of Missouri, E. F. C. Harding, president,
Jefferson City; Howard M. Shirkey, secretary, Richmond.
Missouri Association of County Judges, G. W. Pine, president, Palmyra;
Curtis Hill, secretary, Columbia.
Missouri Highway Association, Roy F. Britton, president, St. Louis; J. B.
Grigg, secretary, Joplin.
North Missouri Cross State Highway Association, George Robertson,
president, Mexico; John F. Morton, secretary, Richmond.
Missouri Good Roads Association, E. E. E. McJimsey, president, Springfield;
M. V. Carroll, secretary, Sedalia.
Old Trails Road Association, Walter Williams, president, Columbia; E. A.
Mitchell, secretary, Marshall.
Sedalia-Springfield Highway Association, W. S. Jackson, president, Warsaw;
M. V. Carroll, secretary, Sedalia.
Short Line Route Association, W. R. Littell, president, Tarkio; F. S. Travis,
secretary, Tarkio.
St. Joe-Des Moines Interstate Trail Association, W. A. Hopkins, president,
Lamoni; Dan'l Anderson, secretary, Lamoni, Ia.
St. Joe-Des Moines Ayr Line Association, A. I. Smith, president, Mt. Ayr;
H. C. Beard, secretary, Mt. Ayr, Ia.
The Brotherhood of Good Road Draggers, G. W. Batterson, president,
Sturgeon; Omar D. Gray, secretary, Sturgeon.
Barry County Good Roads Association, J. F. Normond, president, Monett;
Bert Robbins, Secretary, Cassville.
Barton County Good Roads Association, W. J. Evilsizer, president, Lamar;
James Graham, secretary-treasurer, Lamar.
Cass County: Westline Good Roads Association, G. W. Stark, secretary,
Westline.

Davies County Good Roads Association, George A. Iddings, president, R.F.D. 4, Pattonsburgh; Harvey B. Miller, secretary, Gallatin.
 Franklin County Good Roads Association of St. Clair, C. E. Briegleb, president, St. Clair; Dr. W. E. Kitchell, secretary, St. Clair.
 Howard County: Chariton Township Good Roads Association, Owen Harrison, president, Glasgow; E. W. Price, Secretary, Glasgow.
 Jasper County 365 Day Road Club, J. D. Clarkson, president, Carthage; Chas. A. Blair, secretary, Carthage.
 Perry County Good Roads Association, Robert H. Hudson, president, St. Marys; J. F. DeLassus, secretary, Crosstown.
 St. Louis County Highway and Waterway Association, Gottlieb Bayer, president; Chesterfield, Fred Mueller, secretary, Clayton.
 St. Louis County Olivette-Stratman Improvement Association, M. B. Greensfelder, president, Clayton; H. H. Elbring, secretary, Clayton.
 Vernon County: Nevada Good Roads Club, R. A. Buckner, president, Nevada; J. M. Clack, secretary, Nevada.

Montana

Montana Good Roads Congress, Mr. Brown, president, Great Falls; P. N. Bernard, secretary, Kalispell.
 Committee on State Road Project, Montana Society of Engineers, Clinton H. Moore, secretary, Butte.
 Cascade County Good Roads Association, A. R. Wheeler, president, Great Falls; Walter S. Clark, secretary, Great Falls.
 Lewis and Clarke County: Helena Good Roads Association, Lewis Penwell, president, Helena; A. C. Johnson, secretary, Helena.
 Sweet Grass County Good Roads Association, Harvey Coit, president, Big Timber; Dorman Kellogg, secretary, Big Timber.

Nebraska

Meridian Road Association, Charles Baugh, York, secretary.
 Boone County Good Roads Association, D. J. Poynter, secretary, Albion.
 Brown County: Ainsworth Branch of Trans-Continental Route to Pacific Coast, John B. Stoll, secretary, Ainsworth.
 Johnstown Div. of Trans-Continental Route to Pacific Coast, Ed. Bolhe, Johnstown.
 Long Pine Div. of Trans-Continental Route to Pacific Coast, W. A. Bucklin, secretary, Long pine.
 Cass County Good Roads Association, C. E. Tefft, secretary, Weeping Water.
 Cherry County: Wood Lake Good Roads Association, W. F. Parker, secretary, Wood Lake.
 Colfax County Good Roads Association, J. E. McNabb, secretary, Schuyler.
 Dawes County: Chadron Good Roads Association, W. S. Gillam, secretary, Chadron.
 Dodge County Good Roads Association, George F. Staats, secretary, Fremont.
 Douglas County Good Roads Association, W. J. Kirkland, secretary, Omaha.
 Hall County: Grand Island Good Roads Club, A. M. Connors, secretary, Grand Island.
 Howard County Good Roads Association, A. L. Baliman, secretary, St. Paul.
 Lancaster County Good Roads Association, Fred C. Fiske, secretary, Lincoln.
 Madison County Good Roads Association, C. B. Dalter, secretary, Madison.
 Nance County Good Roads Association, J. D. Barnes, secretary, Fullerton.

Scotts Bluff County Auto and Good Roads Association, C. A. Morrill, secretary, Scotts Bluff.
Washington County: Arlington Auto and Good Roads Association, R. A. Davies, secretary, Arlington.

New Jersey

New Jersey Association of County Engineers, Joshua Doughty, Jr., president, Somerville; E. E. Reed, secretary, Trenton.

New Mexico

Bernalillo County: Ocean to Ocean Highway Association, D. K. B. Sellers, president, Albuquerque, N. M.
Quay County Good Roads Association, J. W. Coon, president, Tucumcari, N. M.; R. A. Prentice, secretary, Tucumcari, N. M.
New Mexico Good Roads Association, Ralph E. Twitchell, president, Santa Fe; D. R. Lane, secretary, Albuquerque.
Northern New Mexico Good Roads Association, L. S. Wilson, president, Raton; F. E. Van Dusen, secretary.
State Association of Highway Officials, Francis E. Lester, president, Mesilla Park; Harvey M. Shields, secretary, Raton.
Dona Ana County Good Roads Association, Francis E. Lester, president, Mesilla Park.
Lincoln County Good Roads Association, J. W. Laws, chairman, Lincoln.
New Mexico Association of Highway Officials, Francis E. Lester, president, Mesilla Park.

New York

New York State Road Builders Association, John H. Gordon, president, Albany; Joseph W. Manion, secretary, Albany.

North Carolina

Central Highway Committee, H. B. Varner, chairman, Lexington.
Charlotte-Wilmington Highway Association, A. B. Skelding, secretary, Wilmington.
North Carolina Good Roads Association, Joseph Hyde Pratt, secretary, Chapel Hill.
Anson County Good Roads Association, Dr. W. J. McLendon, president, Wadesboro; T. V. Howell, secretary-treasurer, Peachland.
Ashe County Good Roads Association, P. E. Fogle, president, Beaver Creek; W. E. Johnson, secretary, Beaver Creek.
Beaufort County Good Roads Association, George T. Leach, president, Washington; C. L. Morton, secretary-treasurer, Washington.
Bladen County Good Roads Association, O. L. Clark, president, Clarkton; W. J. Davis, secretary, Elizabethtown.
Asheville and Buncombe County Good Roads Association, E. C. Chambers, president, Asheville; B. M. Jones, secretary-treasurer, Asheville.
Burke County: Bridgewater Township Good Roads Association, W. Lyerly, president, Bridgewater; R. A. Abernathy, secretary-treasurer, Bridgewater.
Burke County Good Roads Association, J. E. Erwin, president, Morganton.
Connelly Springs Township Good Roads Association, Allis Coulter, president, Connelly Springs; J. L. Sides, secretary-treasurer, Connelly Springs.
Glen Alpine Township Good Roads Association, Dr. E. A. Hennessee, president, Glen Alpine; J. H. Giles, secretary-treasurer, Glen Alpine.

- Hildebran Township Good Roads Association, J. W. Beach, president, Hildebran; A. L. Yoder, secretary-treasurer, Hildebran.
- Caldwell County: Little River Township Good Roads Association, J. F. Steele, president, Lenoir, R. F. D. 2; F. M. Whitner, secretary, Lenoir, R. F. D. 2.
- Camden County Good Roads Association, P. W. Stevens, president, Shiloh; E. I. Sawyer, secretary-treasurer, Camden.
- Caswell County Good Roads Association, B. S. Graves, president, Yanceyville; J. W. James, secretary-treasurer, R. F. D. 1, Leasburg.
- Carteret County Good Roads Association, C. S. Wallace, president, Morehead City; M. L. Willis, secretary-treasurer, Morehead City.
- Catawba County Good Roads Association, R. L. Shuford, president, Newton, R. F. D. 1; R. P. Caldwell, secretary, Newton.
- Chatham County Good Roads Association, James B. Atwater, president, Bynum; Frank D. Jones, secretary-treasurer, Gulf.
- Chowan County Good Roads Association, J. H. McMullan, Jr., president, Edenton; H. L. Story, secretary-treasurer, Edenton.
- Columbus County Good Roads Association, C. Herbert Smith, president, Acme, R. F. D.; K. Clye Council, secretary, Wanaish.
- Craven County Good Roads Association, R. A. Nunn, New Bern; W. G. Boyd, secretary, New Bern.
- Cumberland County Good Roads Association, T. G. McAlister, president, Fayetteville; W. M. Walker, secretary-treasurer, Fayetteville.
- Currituck County Good Roads Association, E. R. Johnson, secretary-treasurer, Currituck.
- Davidson County: Abbots Creek Good Roads and Agricultural Association, C. D. Motsinger, president, Winston-Salem, R. F. D. 5; C. H. Teague, secretary, Wallburg.
- Arcadia Good Roads and Agricultural Association, J. E. Hill, president, Lexington, R. F. D. 4; C. A. Kimel, secretary, Clemmons, R. F. D. 2.
- Alleghany Good Roads and Agricultural Association, Robert Stokes, president, Newson; J. L. Doby, secretary, Newson.
- Boone Good Roads and Agricultural Association, W. B. Meares, Linwood.
- Cotton Grove Good Roads and Agricultural Association, J. D. Lockabill, president, Southmont; John L. Miller, secretary, Linwood, R. F. D. 2.
- Denton Good Roads and Agricultural Association, Rev. Jefferson Lanning, president, Denton; J. M. Daniel, secretary, Denton.
- Cid Good Roads and Agricultural Association, N. H. Prevo, president, Cid; D. A. Leach, Secretary, Denton.
- Hampton Good Roads and Agricultural Association, John W. Hampton, president, Clemmons, R. F. D. 2; J. L. Nelson, secretary, Clemmons, R. F. D. 2.
- Healing Springs Good Roads and Agricultural Association, James I. Smith, president, Silver Hill, R. F. D. 1; Hurley Daniel, Secretary, Denton, R. F. D. 1.
- Holly Grove Good Roads and Agricultural Association, C. A. Swink, president, Lexington, R. F. D. 2; James F. Deal, secretary-treasurer, Lexington, R. F. D. 2.
- Jackson Hill Good Roads and Agricultural Association, Stokes Smith, president, Newson; C. L. Bedgett, secretary, Jackson Hill.
- Liberty Good Roads and Agricultural Association, T. G. Kindley, president, Lexington; John W. May, secretary, Hannersville.
- Midway Good Roads and Agricultural Association, G. Frank Lindsay, president, Wallburg, R. F. D. 1; P. E. Whicker, secretary, Winston-Salem.
- Reedy Creek Good Roads and Agricultural Association, P. E. Fritts, President, Lexington; R. F. D. 4; J. A. Hendricks, secretary, Lexington, R. F. D. 4.

- Silver Hill Good Roads and Agricultural Association. Joe Hedrick, president, Silver Hill; Grover C. Palmer, secretary, Silver Hill.
- Thomasville Good Roads and Agricultural Association, S. H. Averett, president, Thomasville; L. E. Bird, secretary, Thomasville.
- Tyro Good Roads and Agricultural Association, N. H. Swicegood, president, Lexington, R. F. D. 5; Charles F. Koontz, secretary, Linwood, R. F. D. 1.
- Davidson-Randolph Highway Association. Arthur Ross, president, Ashboro; G. Dan Morgan, secretary-treasurer, Denton.
- Davie County Good Roads Association, T. J. Byerly, president, Mocksville; E. D. Williams, secretary, Mocksville; C. F. Stroud, secretary, Mocksville.
- Duplin County Good Roads Association. Island Creek, Island Creek Township; George R. Ward, president, Wallace; W. B. Brice, secretary-treasurer, Wallace.
- Durham County Good Roads Association, Dr. A. Cheatham, president, Durham; P. C. Graham, secretary-treasurer, Durham.
- Edgecombe County Good Roads Association, B. F. Shelton, president, Tarboro.
- Forsyth County Good Roads Association, Judge H. R. Starbuck, president, Winston-Salem; A. F. Yarborough, vice-president, Winston-Salem.
- Gates County Good Roads Association, Lyeurgus Hofer, president, Gatesville; S. P. Cross, secretary-treasurer, Gatesville.
- Greene County Good Roads Association, E. D. Little, president, Snow Hill, R. F. D. 6; J. E. Debman, secretary-treasurer, Snow Hill.
- Guilford County Good Roads Association, J. Van Lindley, president, Greensboro; S. L. Trogden, secretary-treasurer, Greensboro.
- Halifax County Good Roads Association, John L. Patterson, president, Roanoke Rapids; Charles J. Shields, secretary-treasurer, Scotland Neck.
- Harnett County Good Roads Association, Dr. J. W. Halford, chairman, Chalybeate Springs; C. D. McNeely, secretary, Chalybeate Springs.
- Haywood County Good Roads Association, F. W. Miller, president, Waynesville; James Atkins, secretary, Waynesville.
- Hertford County Good Roads Association, A. C. Vann, president, Ahoskie, W. A. Thomas, secretary, Cofield.
- Johnston County Good Roads Association, W. M. Sanders, president, Smithfield; C. M. Wilson, secretary-treasurer, Wilson's Mills.
- Benson Township Good Roads Association, P. B. Johnson, president, Benson; R. F. Smith, secretary-treasurer, Benson.
- Jones County Good Roads Association. R. L. May, chairman, Trenton; John R. Barker, secretary-treasurer, Trenton.
- Lee County Good Roads Association, J. B. Watson, president, Jonesboro; T. S. Cross, Secretary, Sanford.
- Lenoir County Good Roads Association, Dr. J. M. Parrott, president Kinston; Rev. C. W. Howard, secretary-treasurer, Kinston.
- Lincoln County G. R. Association, W. C. Kiser, president, Lincolnton; Tom. Cansler, secretary Lincolnton.
- McDowell County: Old Fort Township Good Roads Association, Dr. F. H. Ihne, Graphiteville.
- Macon County Good Roads Association, T. M. Green, president, Franklin.
- Madison County Good Roads Association, Jasper Ebbs, president, Spring Creek; Dudley Chipley, secretary-treasurer, Marshall.
- Hot Springs Township Good Roads Association, N. J. Lance, president, Hot Springs; S. W. Brown, secretary, Hot Springs.
- Martin County Good Roads Association, W. C. Manning, president, Williamston; C. H. Godwin, secretary treasurer, Godwin.

- Mecklenburg County Good Roads Association, F. M. Shannonhouse, secretary, Charlotte.
- Mitchell County Good Roads Association, George K. Pritchard, chairman, Bakersville; W. C. Berry, secretary, Bakersville.
- Montgomery County Good Roads Association, Frank Page, president, Bliscoe; O. B. Deaton, secretary-treasurer, Troy.
- Moore County Good Roads Association, Leonard Tufts, president, Pinehurst; J. R. McQueen, secretary-treasurer, Pinehurst.
- Northampton County Good Roads Association, John E. Moore, president, Jackson; A. J. Connor, secretary-treasurer, Rich-Square.
- Orange County Good Roads Association, Frank Nash, president, Hillsboro; secretary-treasurer, Hillsboro.
- Pasquotank County Good Roads Association, W. J. Williams, president, Elizabeth City, R. F. D. 4; G. R. Little, secretary-treasurer, Elizabeth City.
- Pender County Good Roads Association, George J. Moore, president, Atkinson; Laughlin McNeill, secretary-treasurer, Burgaw.
- Perquimans County Good Roads Association, T. F. Winslow, president, Hertford; W. B. Hudson, secretary-treasurer, Hartford.
- Person County Good Roads Association, W. E. Morton, president, Roxboro, R. F. D. 3; J. W. Noell, secretary, Roxboro.
- Pitt County Good Roads Association, R. R. Cotten, president, Bruce; H. A. White, secretary-treasurer, Greenville.
- Randolph County Good Roads Association, J. E. Williamson, president, Worthville; J. B. McCraig, secretary-treasurer, Asheboro.
- Richmond County Good Roads Association, B. F. Reynolds, secretary-treasurer, Rockingham.
- Robeson County Good Roads Association, A. E. White, secretary-treasurer, Lumberton.
- Rockingham County Good Roads Association, J. P. Richardson, president, Reidsville.
- Rowan County Good Roads Association, P. B. Beard, president, Salisbury; J. H. Warburton, secretary, Salisbury.
- Gold Hill Township Good Roads Association, J. W. Peeler, president, Rockwell.
- Rutherford County Good Roads Association, Dr. John C. Twitty, president, Rutherfordton.
- Stanley County Good Roads Association, J. M. Harris, Albemarle.
- Stokes County Good Roads Association, John W. Kurfes, president, Germanton; Eugene Pepper, secretary, Danbury.
- Surry County Good Roads Association, J. B. Sparger, president Mt. Airy; M. F. Butner, secretary-treasurer, Pinnacle.
- Tyrrell County Good Roads Association, F. L. W. Cahoon, president, Columbia; H. S. Swain, secretary-treasurer, Jerry.
- Union County Good Roads Association, W. C. Heath, president, Monroe; W. V. Love, secretary, Monroe.
- Wake County Good Roads Association, Dr. J. M. Templeton, president, Cary; Col. Edward E. Brittain, secretary-treasurer, Raleigh.
- Washington County Good Roads Association, T. W. Blount, president, Roper; W. M. Bateman, secretary-treasurer, Plymouth.
- Wayne County Good Roads Association, George C. Royall, president, Goldsboro; G. A. Norwood, secretary-treasurer, Goldsboro.
- Wilkes County Good Roads Association, H. W. Horton, president, North Wilkesboro; Bruce Craven, secretary-treasurer, North Wilkesboro.
- Yadkin County Good Roads Association, F. W. Hanes, chairman, Yadkinville; W. E. Rutledge, secretary, Yadkinville.

North Dakota

State Highway Improvement Association, Hon. L. B. Hanna, president, Bismarck; J. P. Hardy, secretary-treasurer, Fargo.

Ohio

Ohio Good Roads Federation, Jesse Taylor, president 515 Hartman Building, Columbus; A. H. Huston, secretary, 515 Hartman building, Columbus. Franklin County Good Roads Association, E. A. Peters, president, Groveport; Wm. H. Maise, secretary, 406 Harrison Building, Columbus. Greene County Good Roads Association, H. N. Ensign, president, Jamestown; R. S. Dean, secretary, R. F. D., Xenia. Hamilton County Automobile Club, Dr. C. L. Bonefreeld, president, Gibson Home, Cincinnati; Dr. L. S. Colter, secretary, Gibson Home, Cincinnati. Knox County Good Roads Association, H. C. Devine, president, Mt. Vernon; W. C. Rimer, secretary, Mt. Vernon. Portage County Improvement Association, R. D. Hanna, president, Ravenna; C. R. Sharp, secretary, Ravenna. Preble County Good Roads Association, C. W. Bloom, president, New Paris; C. G. Hawley, secretary, New Paris. Scioto County Good Roads Association, L. Taylor, president, Rarden. Wayne County Good Roads Association, Hon. Ed. S. Werts, president, Wooster. Williams County Good Roads Association, Frank Dolph, president, West Unity; Hon. Wm. Behne, secretary, Bryan. Belmont County: Joint Township Good Roads Committee, C. J. Allison, chairman, Bannock, Ohio. Champaign County: Urbana Good Roads Committee, Joseph Murphy, chairman, Urbana, Ohio. Guernsey County: Cumberland Good Roads Committee, Wm. T. Pater-son, chairman, Cumberland, Ohio. Highland County: Hillsboro Good Roads Committee, Capt. Chas. F. Clark, chairman, Hillsboro, Ohio. Tuscarawas County: Dennison Good Roads Committee, Dr. E. A. Wolf, chairman, Dennison, Ohio. Canal Dover Good Roads Committee, George E. Fertig, chairman, Canal Dover, Ohio. Uhrichsville Good Roads Committee, S. W. Walter, chairman, Uhrichs-ville, Ohio. Sandy Township Good Roads Committee, J. Ira Davy, chairman, Mineral City, Ohio. New Philadelphia Good Roads Committee, James U. Congleton, chair- man, New Philadelphia, Ohio. Washington County: Salem Hall Good Roads Association, J. W. Pryor, president, New Matamoras, Ohio; S. J. Weddle, secretary, New Mata- moras, Ohio.

Oklahoma

Oklahoma State Good Roads Association, W. R. Goit, president; C. C. Hud-son, secretary, Oklahoma City.

Oregon

Oregon Development League Theo. B. Wilcox, president, Portland; C. C. Chapman, secretary, Portland; W. S. Worden, chairman, Good Roads Committee, Klamath Falls. Oregon Association for Highway Improvement, James Cole, vice-president Board of Trade Building, Portland; Philip S. Bates, secretary, 215 Oregonian Building.

Baker County: Huntington Development League, W. J. Woods, president, Huntington; J. E. Paul, secretary, Huntington.
Sumpter District Development League, L. C. Edwards, president, Sumpter; H. E. Hendrix, secretary, Sumpter.
Clackamas County: Canby Development League, R. A. Coe, president, Canby; H. H. Eccles, secretary, Canby.
Oak Grove Improvement Association, H. Thiessen, president, Williamette; J. D. Butler, secretary, Williamette.
Clatsop County: Hammond Development League, Sam Hanson, president, Hammond; William Potter secretary, Hammond.
Seaside Civic Improvement Club, Geo. E. Shaver, president, Seaside; V. M. Spurgeon, secretary, Seaside.
Koos County Good Roads Association, A. T. Morrison, president, Coquille.
Culver Development League, Wm. Boegli, president, Culver; D. B. Troutt, secretary, Culver.
Hampton Valley Improvement Association, A. T. Frame, president, Rolyat; V. Schroder, secretary, Rolyat.
Laidlaw Development League, J. N. B. Gerking, president, Laidlaw; Fred N. Wallace, secretary, Laidlaw.
Curry County Development League, Geo. D. Wood, manager, Gold Beach.
Douglas County Good Roads Association, Henry Hart, president, Roseburg; Carl D. Shoemaker, secretary, Roseburg.
Riddle Development League, R. C. Cutsforth, Riddle; T. W. Johnson, secretary, Riddle.
Grant County: Canyon Citizen's League, F. S. Slater, president, Canyon City; Otis Patterson, secretary, Canyon City.

Rhode Island

League of Improvement Societies in Rhode Island, Harry M. Mays, president, Edgewood; Luther D. Burlingame, secretary, 15 Catalpa Road, Providence.

South Carolina

South Carolina Road Builders Association, E. J. Watson, president, Columbia; W. C. Thomas, secretary, Columbia.
Georgia-Carolina Good Roads Association, E. J. Watson, president, Columbia.
Eastern Carolina Good Roads Association, H. H. Husbands, president, Florence.
South Carolina Good Roads Association, F. H. Hyatt, president, Columbia.
Abbeville County Good Roads Association, Dr. C. C. Gambrell, president, Abbeville.
Aiken County Good Roads Association, J. T. Shuler, president, Aiken.
Anderson County Good Roads Association, W. L. Brisse, president, Anderson.
Bamberg County Good Roads Association, S. G. Mayfield, president, Bamberg.
Barnwell County Good Roads Association, S. Z. Bryan, president, Allendale.
Calhoun County Good Roads Association, J. M. Moss, president, St. Matthew.
Charleston Automobile Club, J. M. Connelly, president, Charleston.
Cherokee County Good Roads Association, T. B. Butler, president, Gaffney.
Chester County Good Roads Association, John R. Alexander, president, Chester.
Dorchester County Good Roads Association, John A. Hiers, president, St. George.

Edgefield County Good Roads Association, S. B. Maya, president, Edgefield.
 Fairfield County Good Roads Club, J. Q. Davis, president, Winnsboro;
 A. Homer Brice, secretary, Winnsboro.
 Greenville County Good Roads Association, William G. Sirrine, president,
 Greenville.
 Kershaw County Good Roads Association, M. C. West, president, Camden.
 Lancaster County Good Roads Association, W. U. Clyburn, president,
 Camden.
 Marion County Road and Highway Commission, L. D. Lide, clerk, Marion.
 Newberry County Good Roads Association, Dr. W. C. Brown, president,
 Newberry.
 Orangeburg County Good Roads Association, F. J. D. Felder, president,
 Orangeburg.
 Pickens County Good Roads Association, W. T. O'Dell, president, Liberty.
 Spartanburg County Good Roads Association, S. T. D. Lancaster, president,
 Pauline.
 Sumter County Good Roads Association, S. A. Harvin, president, Sumter.
 Union County Good Roads Association, J. H. Spears, president, Union.
 Williamsburg County Good Roads Commission, J. A. Kelly, president,
 Kingstree.
 York County Good Roads Association, R. T. Fewell, president, Rock Hall.

South Dakota

Chicago, Black Hills and Yellowstone National Park Highway Association,
 Division of South Dakota and Wyoming, N. E. Franklin, president,
 Deadwood, S. D.; H. W. Troth, secretary, Deadwood, S. D.
 Sioux Falls-Salem-Iroquois Highway Association, L. V. Schneider, presi-
 dent, Salem; O. P. Schmidt, secretary-treasurer, Salem.
 South Dakota Division of the Meridian Road, S. H. Edmunds, secretary,
 Yankton.
 South Dakota Good Roads Association, J. W. Parmley, president, Ipswich;
 H. F. Brownell, secretary-treasurer, Sioux Falls.
 South Dakota Scenic Highway Association, Harry Wentzy, president,
 Rapid City; E. K. Mather, secretary, Mitchell.
 Twin City-Aberdeen-Yellowstone Park Trail, J. W. Parmley, president,
 Ipswich; O. T. Peterson, secretary-treasurer, Hettinger, N. D.
 Sioux Falls-Salem-Huron Road Association, W. F. Alguire, president,
 Ellis; Ray Bowden, secretary, Ellis.
 Beadle County Good Roads Club, A. Lampe, president, Huron; J. McD.
 Campbell, secretary, Huron.
 Hanson County: Alexandria Good Roads Club, John Munsen, president,
 Alexandria; John Dobson, secretary, Alexandria.
 Hutchinson County: Meridian Road Club, A. A. Wipf, president, Freeman;
 A. J. Waltner, secretary, Freeman.
 Lawrence County: Lead-Terry Good Roads Association, J. L. Curran,
 secretary, Lead.
 Sioux Falls Good Roads League, J. L. White, secretary, Sioux Falls.
 Roberts County Meridian Road Committee, Henry S. Morris, chairman,
 Simseton.

Tennessee

Tennessee Highway Association, J. N. Fisher, president, Morristown;
 Cyrus Kehr, secretary, Knoxville.
 Memphis-Bristol Highway Association, C. C. Gilbert, president, Memphis.
 Western Tennessee Good Roads and Drainage Association, J. D. Johnson,
 president, Henderson.

Knoxville-Chattanooga Highway Association, S. H. Thompson, president, Athens.
 Anderson County Good Roads Association, W. L. Owen, president, Clinton.
 Bradley County Good Roads Association, J. W. Beard, president, Cleveland.
 Coke County Good Roads Association, chairman, W. D. McSween, Newport.
 Fayette County Good Roads Association, E. A. Maddox, president, Somerville.
 Grainger County Good Roads Association, Dr. A. E. Foster, president, Blaine.
 Knox County Road and Park Association, Cyrus Kehr, president, 607 Empire Building, Knoxville.
 Loudon County Good Roads Association, J. W. Norwood, president, Martel.
 McMinn County Good Roads Association, R. J. Fisher, president, Athens.
 Madison County Good Roads Association, R. A. Hurt, secretary, Jackson.
 Monroe County Good Roads Association, Charles A. Lowry, president, Madisonville.
 Roane County Good Roads Association, W. C. Shaw, president, Harriman.

Texas

Texas Good Roads Association, W. G. Turner, president, Fort Worth; D. E. Colp, secretary, San Antonio.
 Texas Industrial Congress, Henry Exall, president, Dallas, W. C. Barriekman, secretary, Dallas.
 Texas Division of Meridian Highway
 San Antonio to Galveston Division.
 San Antonio-Laredo Division, D. E. Colp, president, Fort Worth; W. H. Beck, secretary, Fort Worth.
 San Antonio-Laredo Highway, D. E. Colp, president, San Antonio; W. Trickey, secretary, Pearshall.
 San Antonio-Atascosa and Gulf Highway Association, H. M. Martin, president, Pleasanton; W. L. Dunne, secretary, Pleasanton.
 San Antonio-Port O'Connor Highway, J. W. Warren, president, San Antonio; W. H. Vernor, secretary, San Antonio.
 San Antonio-Blanco and Granite Highway Association, Chas. E. Crist, president, Blanco City; R. E. Johnson, secretary, Marble Falls.
 Gulf Coast Good Roads Association, J. H. Hawley, secretary-manager, Galveston.
 East Texas Good Roads Association, G. A. Bodenheim, president, Longview; Dr. A. L. Hathcock, secretary, Palestine.
 Alamo-Victoria-San Jacinto Highway, Judge J. P. Pool, president, Victoria; D. E. Colp, secretary, San Antonio.
 Bell County: Good Roads Association, B. B. Buckoridge, secretary, R. L. Bennett, manager, Temple.
 Bee County Good Roads Association, J. B. Daniels, secretary, Beeville.
 Bexar County Highway Division of the San Antonio Chamber of Commerce, A. M. Fischer, president, San Antonio; D. E. Colp, secretary, San Antonio.
 Blanco County Good Roads Club, Percy T. Brigham, president, Blanco City; Wily Kreuger, secretary, Twin Sisters.
 Brazos County Good Roads Club, L. M. Hewitt, secretary, Bryan.
 Burnett County Good Roads Association, C. A. Read, president, Marble Falls; M. E. Fabion, secretary, Marble Falls.
 Cameron County Good Roads Association, S. C. Tucker, president, Brownsville; L. A. Whitney, secretary, Brownsville.
 Colorado County: Eagle Lake Good Roads Club, Frits Engelhart, president, Eagle Lake.

Crockett County: Ozona Good Roads Association, Chas. E. Davidson, secretary, Ozona.
 Dallas County Good Roads Club, J. F. Zang, president, Dallas.
 Falls County Good Roads Club, G. H. Carter, president, Marlin.
 Guadalupe County Good Roads Club, J. M. Abbott, president, Seguin;
 C. F. Blumberg, secretary, Seguin.
 Guadalupe County Good Roads Association, Chas. Blumberg, president, Seguin; T. L. Abbott, secretary, Seguin.
 Hopkins County Good Roads Club, F. W. Mack, secretary, Sulphur Springs.
 Jefferson County Good Roads Club, T. W. Larkin, secretary, Beaumont.
 Jim Wells County: Business Men's Good Roads Club, J. H. Briggs, president, Alice; Phil Hobbs, secretary, Alice.
 Karnes County Good Roads Association, Dr. King, president, Karnes City;
 W. H. Howard, secretary, Karnes City.
 Kendall County Good Roads Association, Dr. J. F. Nooe, president, Boerne;
 H. H. McFarland, secretary, Boerne.
 Kerr County Good Roads Club, Mr. Schultz, secretary, Kerrville.
 Lampasas County Good Roads Club, J. H. H. Berry, president, Lampasas;
 J. E. Verner, secretary, Lampasas.
 Medina County: Devine Good Roads Club, J. W. Fullerton, president, Devine; Mack Kerchville, secretary, Devine.
 Newton County Good Roads Association, I. B. Alford, president, Burkeville; L. M. Autrey, Newton, secretary.
 Orange County Good Roads Association, Geo. W. Bancroft, president, Orange.
 Robertson County: Calvert Good Roads Association, E. J. McGirick, secretary, Calvert.
 Franklin Good Roads Club, F. S. Estes, Franklin.
 Wilson County Good Roads Association, W. H. King, president, Stockdale;
 T. C. Richardson, secretary, Sutherland Springs.

Note: Practically every town of 5000 inhabitants or over has an active commercial club, and in every case these organizations act as good roads clubs and make the road propaganda one of their chief departments of work. They can be reached by addressing: Secretary, Commercial Club, at the town desired.

Vermont

Greater Vermont Association, Guy W. Bailey, president, Junction; J. P. Taylor, secretary, Burlington.
 West River Valley Association, J. H. Ware, president, Townshend; H. C. Rice, secretary, Brattleboro.
 Addison County: East Middlebury Improvement Society, Edward M. Day, president, East Middlebury; J. A. Douglas, secretary, East Middlebury.
 Bennington County Improvement Association, Guy B. Johnson, president, Center; H. N. Morse, secretary, Manchester.
 Arlington Village Improvement Society, Mrs. I. E. Bronson, secretary, Arlington.
 Bennington County: North Bennington Improvement Association, Mrs. Edward D. Weeling, president, North Bennington; Myron H. Jones, secretary, North Bennington.
 Rutland County: Danby and Mt. Tabor Improvement Society, W. H. Griffith, president, Danby; Mrs. Mabel Tabor, secretary, Danby.
 Windsor County: Woodstock Improvement Society, F. T. Kidder, president, Woodstock; Miss Bertha S. Knapp, secretary, Woodstock.

Virginia

Virginia Road Builders' Association, C. B. Scott, president, Lynchburg; C. T. Scott, secretary, Waynesboro.
 Richmond Society of Engineers, Arthur Scrivenor, president, Richmond; James Bolton secretary Richmond.
 Amelia County Good Roads Association, H. F. Green, president, Amelia Court House.
 Campbell County Good Roads Association, Eugene Ould, president, Evington; W. L. Garbee, Lawler.
 Good Roads Association, Rustburg.
 Charlotte County Good Roads Association, B. P. Eggleston, president, Charlotte Court House.
 Chesterfield County Good Roads Association, Howard Swineford, president, Richmond.
 Dinwiddie County Good Roads Association, J. E. Perkinson, chairman, Dinwiddie.
 Fauquier County Good Roads Association, P. T. Crosby, president, Warrenton.
 Halifax County Good Roads Association, W. Holt Edwards, president, Houston.
 Lunenburg County Good Roads Association, E. P. Wallace, president, Meherrin.
 Nansemond County Good Roads Association, R. H. Beamon, president, Beamon.
 Pittsylvania County Good Roads Association, J. L. Carter, president, Chatham.
 Shenandoah County Good Roads Association, M. H. Bowman, president, Woodstock.
 Spotsylvania County: Fredericksburg Good Roads Association, E. D. Cole, president, Fredericksburg; Thomas H. Harris, secretary-treasurer, Fredericksburg.
 Wise County Good Roads Association, John W. Chalkley, president, Big Stone Gap.

Washington

Washington State Good Roads Association, John A. Rea, secretary, Tacoma.
 Chelan County Good Roads Association, Harry Shotwell, president, Wenatchee; H. A. Saunders, secretary, Wenatchee.
 Clarke County: Dole Good Roads Association, C. H. Muncton, president, Dole; A. J. McPherson, secretary, Dole.
 Ferry County Good Roads Association, W. T. O'Connell, president, Republic; S. H. Richardson, secretary, Republic.
 Grant County Organization, William Ragless, president, Quincy; Leo G. Titus, secretary, Ephrata.
 Island County: Good Roads Association of District No. 5, C. S. Halversen, president, R. D., Clinton; A. K. Hanson, secretary, R. D. Langley.
 Kitsap County: Winslow Good Roads Association, Winslow.
 Pearson Good Roads Association, W. H. Babcock, president, Pearson; G. Fryholm, secretary, Pearson.
 Brownsville Good Roads Association, Jerry Beherns, president, Brownsville; T. U. Townsend, secretary, Brownsville.
 Burley Improvement Club, H. W. Stein, secretary, Burley.
 Kittitas County: Good Roads Association of Kittitas County, Soren Sorenson, president, Ellensburg; H. M. Hathaway, secretary, Ellensburg.
 Klickitat County: Good Roads Association of Road District No. 4, J. S. Eddings, president Centerville; J. A. Miller, secretary Centerville.

Lincoln County Good Roads Association, Albert F. Kramer, president, Almira; Guy G. Harvey, secretary, Davenport.
 Oroville Good Roads Association, Oroville.
 Mason County: Matlock Good Roads Association, Fred Ferris, president, Matlock; M. J. Dunkelberger, secretary, Matlock.
 Okanogan County Good Roads Association, George Bailey, secretary, Riverside.
 Pierce County: Longbranch Good Roads Association & Improvement Club, S. S. Watkinson, secretary, Longbranch.
 Skamania County: Underwood Good Roads Association, W. F. Cash, secretary, Underwood.
 Hood Good Roads Association, F. W. Dehart, secretary, Hood.
 Cook Good Roads Association, P. S. C. Wills, secretary, Cook.
 Collins Good Roads Association, Alex. McKeighan, secretary, Collins.
 Home Valley Good Roads Association, A. B. Hutcheson, secretary, Home Valley.
 Butler Good Roads Association, F. S. Munn, secretary, Butler.
 Cape Horn Good Roads Association, M. B. Stevenson, secretary, Cape Horn.
 Snohomish County Good Roads Association, Dr. W. C. Cox, Everett; W. W. Blaine, secretary, Everett.
 Spokane County Good Roads Association, W. H. Cowles, president, Spokane; Frank W. Guilbert, secretary 411 Empire State Building, Spokane.
 Walla Walla County: Good Roads Association, W. M. Cook, president, College Place; John Moyer, secretary, College Place.

West Virginia

Trans-Allegheny Good Roads Association, George W. Stevend, president, Richmond, Va.; Albert Sydney Johnson, secretary, Union, W. Va.
 Southern West Virginia Good Roads Association, W. J. McClaren, president, Welch, W. Va.; E. L. Ellison, secretary, Beckley, W. Va.
 Central West Virginia Good Roads Association, George Norris, president, Weston, W. Va.; John H. Long, secretary, Heater, W. Va.
 West Virginia Good Roads Association, W. A. MacCorkle, president, Charleston, W. Va.; A. D. Williams, secretary, Morgantown, W. Va.
 Cabell County Good Roads Association, G. A. Northcott, president, Huntington, W. Va.
 Doddridge County Good Roads Association, G. W. Twyford, president, West Union, W. Va.; J. M. Martin, secretary, West Union, W. Va.
 Fayette County Good Roads Association, P. M. Snyder, president, Oak Hill, W. Va.; E. J. Payne, secretary, Oak Hill, W. Va.
 Greenbrier County Good Roads Association, Sam Price, president, Lewisburg, W. Va.; John S. Crawford, secretary, Lewisburg, W. Va.
 Hampshire County Good Roads Association, G. K. Kump, president, Romney, W. Va.
 Kanawha County Good Roads Association, C. C. Dickinson, president, Malden, W. Va.; C. C. Lewis, Jr., secretary, Charleston, W. Va.
 Lewis County Good Roads Association, Stark A. White, president, R.F.D. 6, Weston, W. Va.
 Marshall County Good Roads Association, A. H. Gray, president, Cameron, W. Va.; E. G. Gorby, secretary, Moundsville, W. Va.
 Mason County Good Roads Association, R. P. Bell, president, Point Pleasant, W. Va.; P. T. Burdette, secretary, Point Pleasant, W. Va.
 Mercer County Good Roads Association, Samuel Holroyd, president, Athens, W. Va.; C. T. Boykin, secretary, Bluefield, W. Va.
 Mineral County Good Roads Association, J. C. Watson, president, Keyser, W. Va.; F. H. Babb, Keyser, W. Va.

Mingo County Good Roads Association, F. D. Pfenning, secretary, Williamson, W. Va.
 Monroe County Good Roads Association, J. W. Lynch, president, Union, W. Va.; Albert Sydney Johnson, secretary, Union, W. Va.
 Morgan County Good Roads Association, W. H. Summers, president, Berkeley Springs, W. Va.
 Ohio and Brooks Counties Good Roads Association, Harry Sands, president, Wheeling, W. Va.; Roy B. Naylor, secretary, Wheeling, W. Va.
 Pleasants County Good Roads Association, W. C. Carson, president, St. Marys, W. Va.
 Pocahontas County Good Roads Association, C. B. Swecker, president, Dunmore, W. Va.
 Randolph County Good Roads Association, W. G. Wilson, president, Elkins, W. Va.; James W. Wier, secretary, Elkins, W. Va.
 Tyler County Good Roads Association, J. W. Duty, president, Middlebourne, W. Va.
 Wayne County Good Roads Association, O. J. Ryfe, president, Wayne, W. Va.
 Wetzel County Good Roads Association, L. E. Lantz, president, Jacksonburg, W. Va.; Smith Blair, secretary, Jacksonburg, W. Va.
 Wood County Good Roads Association, Burdette Woodyard, president, Parkersburg, W. Va.; W. J. Alexander, secretary, Parkersburg, W. Va.

Wisconsin

Lake to River Association, Guido Hansen, president-treasurer, Milwaukee; Malcolm J. Mackinnon, secretary, Milwaukee.
 Oconomowoc-Milwaukee Road Association, L. J. Petit, Wisconsin National Bank, Milwaukee.
 Wisconsin Highway Commissioners' Association, H. J. Knelling, president, Pereles Building, Milwaukee; G. H. Mainwaring, secretary-treasurer, Gotham.
 Fox River Valley Highway Association, John Conway, president, Appleton, Wis.
 Dane County: Madison Auto Good Roads Club, John Donald, president, Madison, Wis.; M. J. O'Malley, treasurer, Madison, Wis.
 Lincoln County Good Roads Association, J. A. Emerich, president, Merrill, Wis.; W. D. Martin, secretary, Merrill, Wis.
 Trempealeau County Good Roads Association, F. A. George, president, Whitehall; G. O. Linderman, vice-president, Osseo; J. A. Markham, secretary, Independence; Dr. G. H. Lawrence, treasurer, Galesville.

Wyoming

Association for promoting "Black Hills-Yellowstone Park Highway" N. E. Franklin, president, Deadwood, S. D.; J. D. Gallup, vice-president, Buffalo.
 Northern Wyoming Good Roads Association, Hayden M. White, president, Buffalo; C. A. Harmon, secretary, Upton.
 Wyoming Highway Association, Frank Wood, president, Casper; J. D. Kilborn, secretary, Elk Mountain.
 Albany County Good Roads Association, Elmer Lovejoy, president, Laramie; Robert W. Innes, secretary, Laramie.
 Carbon County Good Roads Association, Raymond Barber, president, Rawlins; Homer A. Menice, secretary, Rawlins.
 Converse County: Good Roads Club of Douglas, Jacob Jenne, president, Douglas; Henry J. Bollin, secretary, Douglas.
 Fremont County Good Roads Association, O. M. Beck, president, Lander, Wyo.; A. H. Maxwell, secretary, Lander, Wyo.
 Laramie County Good Roads Association, H. P. Hynds, president, Cheyenne; C. A. Lane, secretary, Cheyenne.

ADDENDA

Page 88; add to Minnesota digest.—During 1915, a map of State roads was prepared showing that of a total of 12,307 miles so designated, 1414 miles were graded and provided with standard gravel, macadam or concrete surfacing, 785 miles had a gravel surface not standard, and 2597 miles were earth roads brought to standard width and graded. During 1915, over \$1,500,000 was spent on the construction of State-aid roads and over \$465,000 on their maintenance. In 1916, 69 out of a total of 96 counties will grade about 1,560 miles of road, gravel 565 miles and construct concrete culverts and other improvements which will bring the total contemplated expenditure to \$1,755,000. If the remaining counties do a proportionate amount of work, about \$2,225,000 will be spent on State-aid construction, while about \$690,000 will be spent in maintaining the State roads.

Page 89; State-aid Legislation.—The 1916 legislature created a State highway commission of three members holding office for six years, one appointed every two years. The commission is authorized to appoint a State highway engineer and other assistants. It is directed to consider and adopt plans for locating and constructing roads, and to cooperate with the federal authorities in constructing post roads. It is required to hold meetings in each county to encourage road improvements. The State highway engineer is directed to plan improvements of such roads as will form a connected system of main traveled highways; to investigate the methods of road construction best suited to local needs and the availability of local materials for road improvements; to furnish information to county officials and to collect road data from them. The testing facilities of the University of Mississippi and of the Agricultural and Mechanical College are placed at the disposal of the State highway department.

The members of the commission are: J. M. McBeath, Meridian, chairman; D. W. Robbins, Tupelo, and W. T. Denman, McComb.

Page 100; Progress Report.—It is estimated that there are 15,116 miles of road in the State of which 1177 have some kind of hard surface. There are 150 miles of road improved entirely at the expense of the State; none such is now under improvement.

Page 101; Road Funds.—From January 1, 1915, to February 15, 1916, the State spent \$191,343 and the towns \$104,733 on constructing trunk lines, and \$32,844 and \$188,447 respectively on constructing State-aid roads. In the same period the maintenance expenditures by State and towns respectively were: State roads, \$74,658 from the State and nothing from the towns; trunk line roads, \$177,963 and \$34,822; State-aid roads, \$94,273 and \$48,491; Winnesquam bridge, \$17,393 and \$18,792.

Page 106; Road Funds.—The legislature of 1916 passed an act to be submitted to popular vote in the same year, authorizing the State highway commission to lay out 13 State highway routes and to take over and improve existing roads forming parts of these routes. The expense of the work is to be met by \$7,000,000 serial 4 per cent bonds \$500,000 to be retired annually by the proceeds of automobile fees.

Page 156; State-aid Legislation.—The State highway commissioner has recently been granted authority to withhold State-aid funds and convict labor from counties which do not maintain their roads to his satisfaction. He has been authorized to exercise the right of eminent domain.

Page 159; Local Bond Legislation.—A new law requires estimates of the cost of roads to be prepared before a bond election is ordered. After bonds are voted, the board of supervisors must levy annually at least 3 per cent. of the amount of the bonds for the maintenance of the roads.

Page 153; Automobile Registration.—A 1916 law directs all automobile license fees to be used for maintenance by the counties under the direction of the State highway commissioner provided no county shall receive any of the money unless it contributes an equal amount for the same purpose.

Page 163; Highway Officials.—James Allen has succeeded Wm. R. Roy as State highway commissioner, and George F. Cotterill has succeeded Mr. Allen as chief engineer.

Page 401; add:

Canadian Good Roads Association

Officers.—J. Duchastel de Montrouge, Outremont, P. Q., president; F. L. Squires, Toronto, Ont., vice-president; George A. McNamee, Toronto, Ont., secretary and treasurer.

Page 405, add:

Ocean to Ocean Highway Association

Officers.—J. S. Mactavish, Magdalena, New Mexico, president; H. O. Barker, Banning, California, W. M. Petersen, White River, Arizona, and D. K. B. Sellers, Albuquerque, New Mexico, vice-presidents; C. B. Sedillo, Magdalena, New Mexico, secretary; Fred Nelson, St. John, Arizona, treasurer.

Page 420, add:

New Hampshire Good Roads Association; Ovid F. Winslow, Nashua, president; George P. Winn, Nashua, secretary and treasurer.

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